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A STUDY OF SPACE STATION NEEDS, ATTRIBUTES & ARCHITECTURAL OPTIONS

FINAL REPORT

VOLUME II • TECHNICAL
BOOK 1 • MISSION REQUIREMENTS
APPENDIXES I & II

22 April 1983

Submitted to
National Aeronautics and Space Administration
Washington, D.C. 20546

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APPENDIX I

MISSION REQUIREMENTS DATA BASE

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TABLE OF CONTENTS

INTRODUCTION

The Space Station Mission requirements data base consists of 149 attached and free-flying missions each of which is documented by a set of three interrelated documents as shown in Figure 1-1:

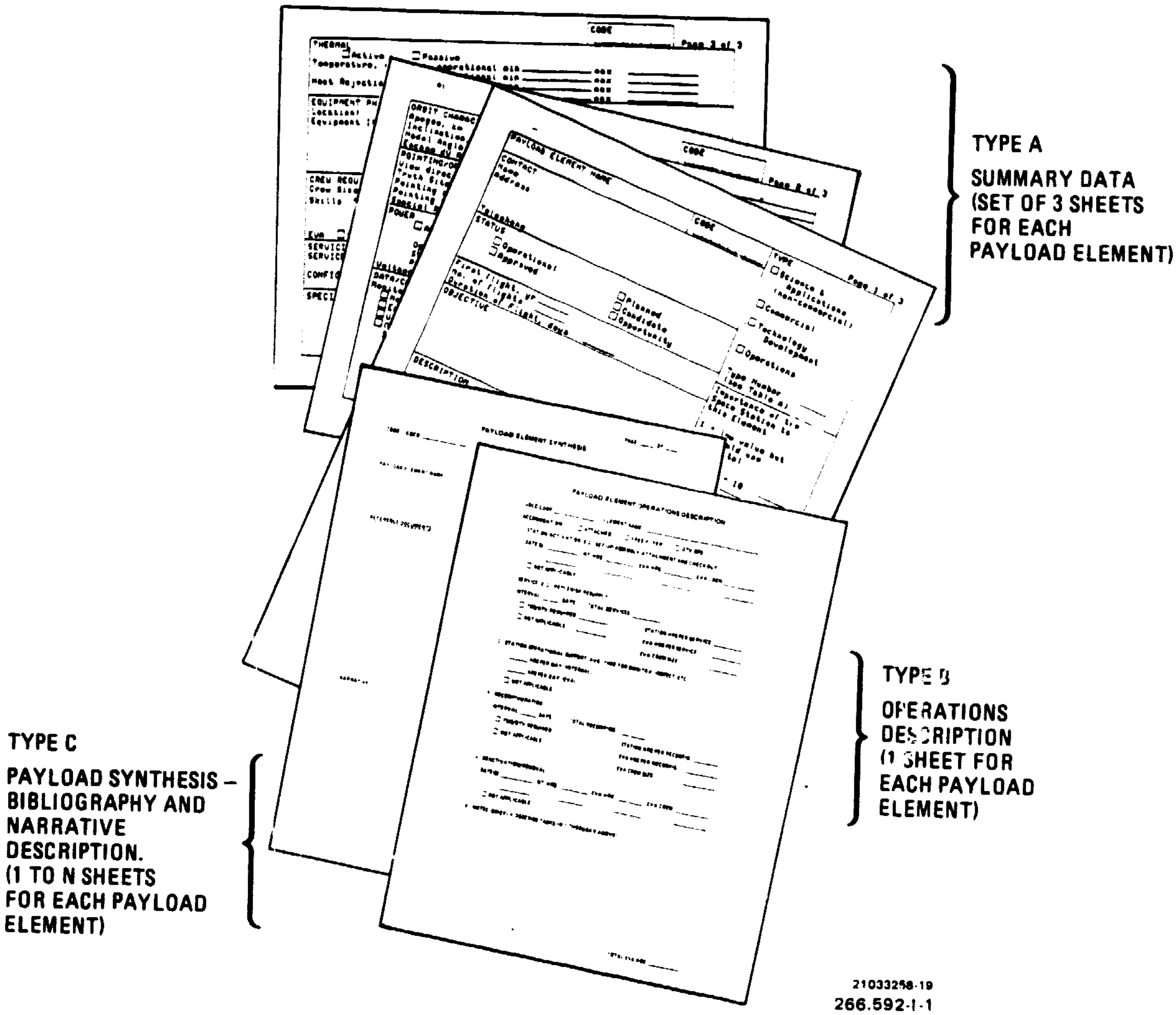
- Type A - NASA LaRC Data Sheets - with three sheets comprising a set for each payload element described. These sheets contain user payload element data necessary to drive Space Station architectural options.
- Type B - GDC-derived operations descriptions that supplement the LaRC payload element data in the operations areas such as further descriptions of crew involvement, EVA, etc. One operations sheet is provided for each payload element.
- Type C - Payload elements synthesis sheets used by GDC to provide requirements traceability to data sources and to provide a narrative describing the basis for formulating the payload element requirements. One or more synthesis sheets are provided for each payload element identified.

The data base has been developed for the set of 149 missions that are categorized and tabulated in ascending order in this appendix. Each of the payload elements is documented by a package consisting of all three types of data items identified above. A minimum of five descriptive data sheets is contained in each "package" - three LaRC summary data sheets, one operations description data sheet, and one or more payload synthesis sheets. The following paragraphs describe the content and preparation guidelines for each type of data sheet in further detail.

It should be noted that the payload elements contained in this appendix are described in terms of their prefered accommodation mode. If a payload is alternatively accommodated in an acceptable mode, the physical characteristics may change, e.g., a pointing mount that is part of an attached payload may be eliminated if the payload is alternatively accommodated on a free-flyer that has the required pointing accuracy.

National security payload elements are not discussed in this appendix. Discussion is contained in Volume II Book 4.

Figure I-1
Payload Element Documentation



GUIDELINES FOR PREPARATION OF NASA LaRC PAYLOAD ELEMENT DATA DESCRIPTIONS

The General Dynamics Convair Division interpretation of selected entries appearing on the NASA LaRC payload element data sheets is described in the following paragraphs and includes any field size, or other limitations that have been provided by LaRC. LaRC data constraints are flagged by an asterisk in the data descriptor title. For convenience the sample blank forms shown have been annotated with reference designators that may be used to key to the following descriptions of the data to be entered in each applicable area.

Page 1 of 3

PAYLOAD ELEMENT NAME (1)	CODE G D C D (2)	TYPE ☐ Science & Applications (non-commercial) ☐ Commercial (3) ☐ Technology Development ☐ Operations Type Number ____ (see Table A)
CONTACT Name (4) Address Telephone (5)		
STATUS (6) ☐ Operational ☐ Approved ☐ Planned ☐ Candidate ☐ Opportunity		
First flight, yr (7) ____ No. of flights ____ (8) Duration of Flight, days (9) ____		Importance of the Space Station to this Element 1 = low value but could use 10 = vital Scale 1 - 10 (12) ____
OBJECTIVE (10)		
DESCRIPTION (11)		

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ORIGINAL PAGE IS
OF POOR QUALITY

CODE
G D C D ___ (2)

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ORBIT CHARACTERISTICS
Apogee, km ___(13)___ Perigee, km ___(13)___ Tolerance + ___(14)___ - ___(14)___
Inclination, deg ___ Tolerance + ___(15)___ - ___(15)___
Nodal Angle, deg ___ Ephemeris Accuracy, m ___
Escape dV Required, m/s ___

POINTING/ORIENTATION
View direction (17) ☐ Inertial ☐ Solar (18) ☐ Earth
Truth Sites (if known) ___
Pointing accuracy, arc sec ___(19)___ Field of view, deg ___
Pointing Stability (Jitter) arc sec/sec (20) (20) ___
Special Restrictions (Avoidance) ___ (20) ___

POWER (22)
☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	___	___
Standby	___	___
Peak	___	___

☐ Continuous

Voltage, V ___ Frequency, Hz ___

DATA/COMMUNICATIONS
Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ___(23)___
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ___ Frequency (MHZ) ___
☐ On-Board Data Processing Required
Description (24) ___

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ___
Film (Amount) ___ Voice (Hrs/Day) (25) ___
Live TV (Hrs/Day) ___ Other ___
On-Board Storage (MBIT) ___
Data Dump Frequency (Per Orbit) ___
Recording Rate (KBPS) ___(26)___ Downlink Frequency (MHZ) ___

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CODE
G D C D ___ (2)

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THERMAL (27)
☐ Active ☐ Passive

		min	max
Temperature, deg C	operational	___	___
	non-operational	___	___
Heat Rejection, w	operational	___	___
	non-operational	___	___

EQUIPMENT PHYSICAL CHARACTERISTICS
Location: ☐ Internal ☐ External ☐ Remote (28)
Equipment ID/Function ☐ Pressurized ☐ Unpressurized (29)
L,m (30) ___ W,m ___(30)___ H,m ___(30) Stowed
L,m ___(31) W,m ___(31)___ H,m ___(31)___ Deployed
Launch mass, kg ___(32)___
Consumables Types ___(33)___
Acceleration sensitivity, g min ___ max ___(34)

CREW REQUIREMENTS
Crew Size ___ Task Assignment ___(36)___
Skills (See Table B)

SKILL (37)						
LEVEL	(38)					
Hrs/Day		(39)				

EVA (40) ☐ YES ☐ NO Reason ___(40)___ Hrs/EVA (41) ___

SERVICING/MAINTENANCE
SERVICE: Interval, days ___ Consumables, kg ___
Returnables, kg ___ Man Hours ___(42)
CONFIGURATION CHANGES: Interval, day ___ Man/Hrs Req. ___(43)
Deliverables, kg ___ Returnables, kg ___

SPECIAL CONSIDERATIONS/See Instructions
(44)

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DATA DESCRIPTORS

1. Payload Element Name* - Descriptive title (32-character limit)

2. Code* - Enter 4-digit identifier, GDCD XXXX on each data sheet as follows:

4-DIGIT IDENTIFIER*

Type	Number Range
Science and Applications	0000-0999
Commercial	1000-1999
Technology Development	2000-2999
Operations	3000-3999
Other	4000-4999
National Security	5000-5999

3. Type* - Select the most appropriate payload element type and enter the most appropriate single type number designator from Table A.

Table A
Payload Element Type*

SCIENCE AND APPLICATIONS
1. Astrophysics
2. Earth and Planetary Exploration
3. Environmental
4. Life Sciences
5. Materials Processing

COMMERCIAL
6. Earth and Ocean Observations
7. Communications
8. Materials Processing
9. Industrial Services

TECHNOLOGY DEVELOPMENT

10. Materials and Structures
11. Energy Conversion
12. Computer Science and Electronics
13. Propulsion
14. Controls and Human Factors
15. Space Station Systems and Operations
16. Fluid and Thermal Physics, Physics, and Chemistry

OPERATIONS

17. Maintenance
18. Other

4. 5. Contact Name, Address, Telephone* - Enter the following standard. (Name, 1 line, 32-character limit; address, 4 lines, 24-character/line limit; telephone, 1 line, 32-character limit)

W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair
P.O. Box 85357
San Diego, CA 92138
(619) 277-8900, Ext 3778/2130

6. Status - The single most appropriate category. Reserve "approved" status for those payload elements appearing as line itmes on the current NASA budget.

7. First Flight - Initial launch year. If more than one launch is required, enter the other launch dates elsewhere on the data sheet. For a mission launched before the Space Station era (before 1990) and still in operation during the 1990-2000 decade, show the initial launch date. For a mission launched before 1990 but returned to earth for refurbishment and relaunched, enter the later launch date after which Station interfacing operations will occur. (NOTE: The first flight date reflects the baseline mission data set prescribed in Volume II, Book 1, Section 4-4 and has in some cases been slipped from the user desired data as described in Book 1, Section 3-4.)

8. Number of Flights - The total number of flights required to accomplish the mission objectives. Does not account for multiple flights to deliver an oversize payload element, or multiple flights for service, or flights for earth return.

9. Duration of Flight - Mission duration for the initial launch. If different mission durations for subsequent flights, describe elsewhere on the data sheet.

10. Objective* - (7 lines, 72-characters/line limit)

11. Description* - (9 lines, 108-characters/per line limit)

12. Importance - Values near 1 indicate a benefit. Values near 10 show that the Space Station is vital to accomplishment of the objective of the mission. Values between 1-10 reflect the degree of significance judged appropriate.

13. Preferred Orbit - Preferred orbit apogee and perigee altitude and inclination. If not critical, ANY is entered. If Space Station altitude is preferred, enter LEO.

14. 15. Acceptable Orbit - The tolerance from the perferred orbit characteristic denoting the acceptable range of orbit altitudes and inclinations that will permit the primary payload objectives to be accomplished. Some degradation in overall mission results may occur.

16. Escape dV Required - For planetary payload elements only.

17. Viewing Direction - Desired viewing direction or orientation, i.e., inertial, solar or earth. Any other appropriate direction requires explanation, and is recorded as "special considerations", item 44.

18. Truth Sites* - Truth site description, e.g., location, type, etc. (60-character limit).

19. Pointing Accuracy - The required pointing accuracy at the interface between the instrument and its carrier. Where the payload definition includes a pointing mount, the accuracy required at the base of the mount is typically 30 to 60 arc minutes (see Figure I-2).

20. Pointing Jitter - The maximum allowable angular rate of the line-of-sight (see Figure I-2).

21. Special Restrictions (Avoidance)* - Describe pointing constraints (50-character limit).

22. Power - Describe the input power level and duration when operating, peak power input level and corresponding time, or other power related parameters. For a payload element attached to the Space Station, the power matches the integrated payload definition at the interface. For free-flyers the power level can be for the science payload and/or spacecraft while operating, or, if known, the power level while attached to the Station for service/checkout.

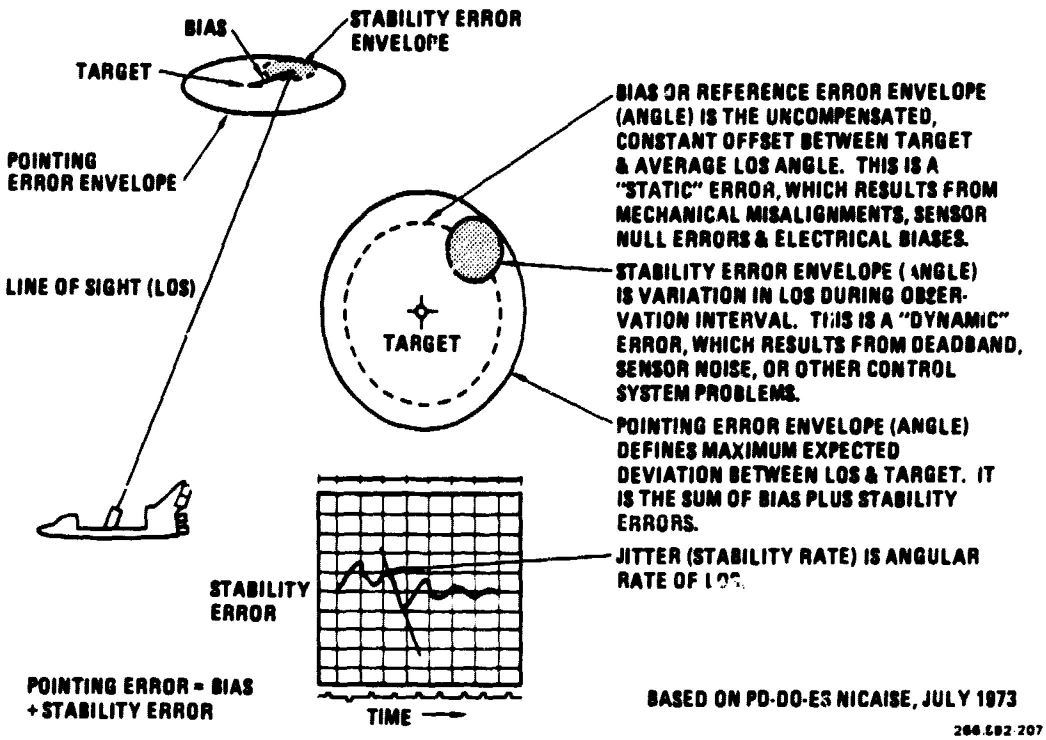
23. Data Monitoring Requirements* - Other requirements (30-character limit).

24. On-Board Data Processing Description* - (80-character limit).

25. Other Data Types* - (30-character limit).

26. Recording Rate - The ditigal data rate flowing from the payload (including both science and housekeeping data) whether recorded or not.

Figure I-2. Line of Sight Error Definition



(27.) Thermal - The thermal characteristics needed by the payload equipment at the interface with the Space Station (unless otherwise specified, e.g., the payload requirements for a free-flyer).

(28.)(29.) Equipment Location, ID, Function - The primary equipment location, e.g., external/unpressurized. If equipment is both pressurized and unpressurized, explain the secondary equipment elsewhere in the data sheet.

(30.) Stowed Dimensions - The estimated dimensions when stowed for delivery in the Shuttle cargo bay with length (L) axis corresponding to cargo-bay longitudinal axis. If cylindrical shape, enter width (W) and height (H) as same dimension.

(31.) Deployed Dimensions - The envelope dimensions of payload equipment mounted internally or externally to the Station or in the free-flying configuration when the equipment is fully deployed, erected, or constructed. Unless otherwise specified, excludes consideration of crew access volume, aisle space, or other packaging effects.

(32.) Launch Mass - Normally the mass of the payload equipment as defined for the expected accommodation mode, e.g., the payload weight for a station-attached payload, which could include: a mounting structure, power and signal interface units, cold plates and coolant pump packages, and appropriate instrument pointing system or merely the individual instruments or instrument groups. For free-flyers the mass may be for either the integrated instrument package or complete spacecraft/scientific equipment weight; or the total upper stage payload weight ("throw" weight), which includes satellite subsystem.

(33.) Consumables Type* - Usable materials included in Launch Mass, e.g., spacecraft propellants (30-character limit).

(34.) Acceleration Sensitivity: The highest permissible acceleration level during critical periods of experiment or processing operations. This is relatively long term, unidirectional acceleration as induced by atmospheric drag, drag, stationkeeping or reboost thruster operation, or rotation for reorientation.

(35.) Crew Size - The minimum number of crew persons required simultaneously to support routine payload operations.

36. Task Assgnment - The critical function(s) performed by the crew to support routine payload element operations.

37. 38. Skill Type, Skill Level* - The minimum skill requirements to perform the mission objectives. If more than one, specify each in accordance with Table B. (Note: more than one skill does not necessarily imply more than one crew person, since cross-training at acceptable levels is assumed).

CREW SKILLS*
Table B

Skill Type

1. No Special Skill Required
2. Medical/Biological
3. Physical Sciences
4. Earth and Ocean Sciences
5. Engineering
6. Astronomy
7. Spacecraft Systems

Skill Levels

1. Task Trainable
2. Technician
3. Professional

39. Crew Time - The total number of hours per day devoted to planned payload operations. This is an average over the mission duration.

40. EVA/Reason* - An x check indicates that EVA is required for the reason noted, e.g., to set up, operate, service, and/or reconfigure or tear down the payload equipment (the EVA reason is limited to 20 characters).

41. HRS/EVA - Interpreted to be the summation of EVA hours for all mission EVA-related operations to include, for example, the EVA portion of all reconfiguration or service operations conducted throughout the mission lifetime.

42. Service (Manhours) - The total number of manhours estimated for a single service operation. Manhours for service can include both IVA and EVA time. If EVA time is needed, the total EVA time for all the service operations during the mission are totaled and included in item 41. The total number of servicing operations may be derived from the service interval and mission duration, or by consulting the related operations data sheet.

43. Reconfiguration (Manhours) - The same concept described for service operations manhours applies to reconfiguration operations manhours.

44. Special Considerations* - Includes special requirements or other pertinent information about payload configuration, resources, multiple payloads, etc., and includes the following examples: (6 lines, 108-character/ line limit).

Examples of this category*

Special environmental criteria
Special servicing or support requirements
Unique operational characteristics
Orbit changing needs
Safety considerations

GUIDELINES FOR PREPARATION OF PAYLOAD ELEMENT OPERATIONS DESCRIPTIONS

Operations data captured in the Payload Element Operations Description data sheet is intended to augment the data contained in the NASA LaRC documentation. GDCD code numbers and payload element names are the same. The total EVA hours at the bottom of the operations sheet is the sum of all the EVA hours and corresponds to the entry on the third LaRC data sheet. Accommodation is the user preferred mode. Requirements for OTV/TMS are noted only when required by the mission, e.g., for geosynchronous orbit placement, however, derived requirements for use of specific elements (such as TMS for servicing) are not precluded in subsequent accommodation analyses.

A sample operations data sheet format has been annotated with reference designators to provide a key to the following descriptions of data to be entered on the sheet for each payload element.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GOCD CODE ____________ ELEMENT NAME ______________________________

ACCOMODATION: ☐ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) ___1.1___ INT. HRS ___1.2___ EVA HRS ___1.3___ EVA CREW ___1.4___

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ___2.1___ DAYS TOTAL SERVICES ___2.2___

   ☐ TMS/OTV REQUIRED __________ STATION HRS PER SERVICE ___2.3___

   ☐ NOT APPLICABLE __________ EVA HRS PER SERVICE ___2.4___

   EVA CREW SIZE ___2.5___

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ___3.1___ HRS PER DAY (INTERNAL)

   ___3.2___ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ___4.1___ DAYS TOTAL RECONFIGS. ___4.2___

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ___4.3___

   ☐ NOT APPLICABLE EVA HRS PER RECONFIG. ___4.4___

   EVA CREW SIZE ___4.5___

5. DEACTIVATION/REMOVAL

   DATE(S) ___5.1___ INT. HRS. ___5.2___ EVA HRS ___5.3___ EVA CREW ___5.4___

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

TOTAL EVA HRS __________

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DATA DESCRIPTORS

1. STATION ACTIVATION

1.1 Date. The date after which the Space Station will accommodate and interface with the payload. (Not necessarily the payload first flight date.)

1.2 Int. Hrs. Station hours required for initial checkout. If no internal (IVA) hours are shown here, it is because:

a) payload is a free-flyer, or

b) initial checkout hours are not unique (e.g., assembly) and, therefore, are considered part of normal station operations.

1.3 EVA Hrs. EVA hours required to initially assemble or attach a payload to the Space Station. Routine placement of a payload on a berthing port or similar operations is considered part of station operations. Reference TM-82482, MSFC, April 1982, for typical operations to be assigned to man, man-machine, or machine.

1.4 EVA Crew. The estimated minimum EVA crew size (not a multiplier of item 1.3).

2. SERVICE

2.1 Interval. The service interval as shown in NASA LaRC data sheets.

2.2 Total Services. Total number of service trips over the life of the payload, normally between the years 1990 and 2000.

2.3 Station Hrs Per Service. The time required for the internal crew per service e.g., to control the TMS (or equivalent) for retrieval of free-flyers or for support of EVA. Excludes any station operations support that is not payload peculiar.

2.4 EVA Hrs Per Service. The EVA time required per service by the EVA crewmenber(s). EVA is required for manned functions such as reconfiguration as defined in NASA TM-82482, MSFC April 1982, Figure 4. EVA is also assumed for consumables replacement on payloads launched before the TMS becomes available.

2.5 EVA Crew Size. The estimated minimum EVA crew required to perform the task. (Not a multiplier of item 2.4.).

3. STATION OPERATIONAL SUPPORT

3.1 Hrs Per Day (Internal). The average number of IVA hours the Space Station crew will spend in controlling and monitoring an attached payload over the life of mission.

3.2 Hrs Per Day (External). If applicable, the average number of hours that EVA would be required on a continuing and routine payload peculiar task such as daily inspection.

4. RECONFIGURATION

4.1 Interval. The reconfiguration interval as shown in NASA LaRC data sheets.

4.2 Total Reconfiguration. The total number of reconfigurations planned for the payload lifetime, normally between the station activation date and the year 2000.

4.3 Station Hrs Per Reconfiguration. The payload peculiar time required inside the Space Station to support an individual reconfiguration.

4.4 EVA Hrs Per Reconfiguration. The EVA time required per reconfiguration - Reference TM-82482.

4.5 EVA Crew Size. The estimated EVA crew required to perform the task (not a multiplier of item 4.4).

5. DEACTIVATION/REMOVAL

5.1 Date. The date the payload is deactivated or removed from station accommodation. N/A is used if the payload remains to support a later experiment or if payload continues past year 2000.

5.2 Int. Hours. Station hours required for special removal and repackaging of payload. Routine removal considered part of station operations.

5.3 EVA Hours. EVA hours required for the disassembly of a payload.

5.4 EVA Crew. The estimated minimum EVA crew size (not a multiplier of item 5.3.)

GUIDELINES FOR PREPARATION OF PAYLOAD ELEMENT SYNTHESIS DATA

Traceability of requirements is a key factor to the validation of payload element requirements. The payload element synthesis sheet (following) shows the guidelines for preparation of supporting data.

Code: GDCD

PAYLOAD ELEMENT SYNTHESIS

Code No. and Name from NASA LaRC Data Sheets

Payload Element Name:

Reference Documents:

Prepare a bibliography of reference documents, meetings, telecons, etc. used as source material to prepare payload element requirements. Be as specific as possible. Include report titles, dates, and page number(s) if applicable.

Narrative:

Describe the payload element synthesis process.

Reference the key requirements data sources (from documents above), and identify assumptions, ground rules, scaling factors, derived data, estimates, augmentation, etc, used to prepare the payload element description on the data sheet. Be as specific as possible in tracing requirements. Attempt to answer the question. "Where did that requirement come from?". Use continuation sheets as necessary.

In addition to payload element synthesis/traceability, this sheet should be used to describe or collect background data and technical features of the payload element which could not adequately be described on the 3-page LaRC data sheets. Reference to the LaRC data entries where appropriate. Attach sketches or whatever would be useful. This sheet may also be used to document overall requirements applicable to more than one payload element within a discipline.

DATA SHEETS

SCIENCE AND APPLICATIONS MISSIONS

Section 1.1

Discipline Astrophysics

GDCD ID NO.	PAYLOAD ELEMENT NAME
	ASTRONOMY
0000	Starlab
0001	Large Deployable Reflector
0002	Far UV Spectroscopy Explorer
0003	Very Long Baseline Interferometry Demo
0004	Space Telescope
0005	Shuttle IR Telescope Facility
	HIGH ENERGY
0030	Gamma Ray Observatory
0031	High Throughput Mission
0032	Large Area Modular Array
0033	Advanced X-Ray Astrophysics Facility
0034	High Resolution X and Gamma Ray Spectrometer
0035	High Energy Isotope Experiment
0036	Spectra of Cosmic Ray Nuclei
0037	Transition Radiation and Ionization Calorimeter
0038	X-Ray Timing Explorer
	SOLAR PHYSICS
0060	Solar Internal Dynamics Mission
0061	Solar Corona Diagnostics Mission
0062	Advanced Solar Observatory

PAYLOAD ELEMENT NAME
Starlab

CODE G D C D 0 0 0 0

TYPE

- [x] Science & Applications (non-commercial)
- [ ] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A) 1

CONTACT

Name / Address: W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- [ ] Operational
- [ ] Approved
- [x] Planned
- [ ] Candidate
- [ ] Opportunity

First flight, yr 1992
No. of flights 1
Duration of Flight, days 1100

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

OBJECTIVE To investigate the visual, ultra-violet, and near infrared properties of extragalactic space, the Milky Way galaxy, and the solar system with both high spatial resolution and wide-angle imaging.

DESCRIPTION The first Starlab mission is to be by Shuttle. Then, it becomes an excellent candidate for Space Station residency. The mode of operation then allows a large significant usage under manual control of station personnel. The facility consists of a telescope with an adaptable focal plane, star tracker, mount, and electronics.

CODE G D C D 0 0 0 0 0

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 35 - 30
Inclination, deg 28.5 Tolerance + 28.5 - 0
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☒ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec 150 Field of view, deg 1.6
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) 35° from sun, 15° from earth/moon, 5° dark earth

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	2220	18
Standby		
Peak	3890	

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☒ Other TDRSS Compatible
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☒ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 16,000 Downlink Frequency (MHZ) ______

CODE G D C D 0 0 0 0

THERMAL

[X] Active [ ] Passive

		min		max
Temperature, deg C	operational	min	2	max 45
	non-operational	min		max
Heat Rejection, w	operational	min		max 200
	non-operational	min		max

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: [ ] Internal [X] External [ ] Remote

Equipment ID/Function [ ] Pressurized [X] Unpressurized

L,m 6.5 W,m 4.5 H,m 4.5 Stowed

L,m 13 W,m 7.0 H,m 4.5 Deployed

Launch mass, kg 3280

Consumables Types

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 1 Task Assignment

Skills (See Table B)

SKILL	6					
LEVEL	2					
Hrs/Day	2					

EVA [X] YES [ ] NO Reason Reconfigure Hrs/EVA 16

SERVICING/MAINTENANCE

SERVICE: Interval, days ____ Consumables, kg ____

Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day 360 Man/Hrs Req. 8

Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

1) Condensation sensitive
2) Pointing stability for 30-minute periods

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0000 ELEMENT NAME STARLAB

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER* ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1992 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   2 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL 360 DAYS TOTAL RECONFIGS. 2

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☐ NOT APPLICABLE EVA HRS PER RECONFIG. 8

   EVA CREW SIZE 2

5. DEACTIVATION/REMOVAL

   DATE(S) 1995 INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

* Free Flyer accommodation is an alternate mode, and if used will require re-evaluation of all requirements

1. Attach to Station - Station OPS
3. Pointing control and monitoring
4. Equipment update
5. Remove and repackage for earth return-station OPS

TOTAL EVA HRS 16

Code: GDCD 0000

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Starlab

Reference Documents:

1. Science and Applications Requirements for Space Station, NASA Hq., P 10, RCVD 11/17/82.
2. Astrophysics Project Concept Document, GDC Document No. 10-004H, October 1980.
3. Science and Application Space Platform Payload Accommodations Study, SP 82-MSFC-2583, March 1982 p. A-13.

Narrative:

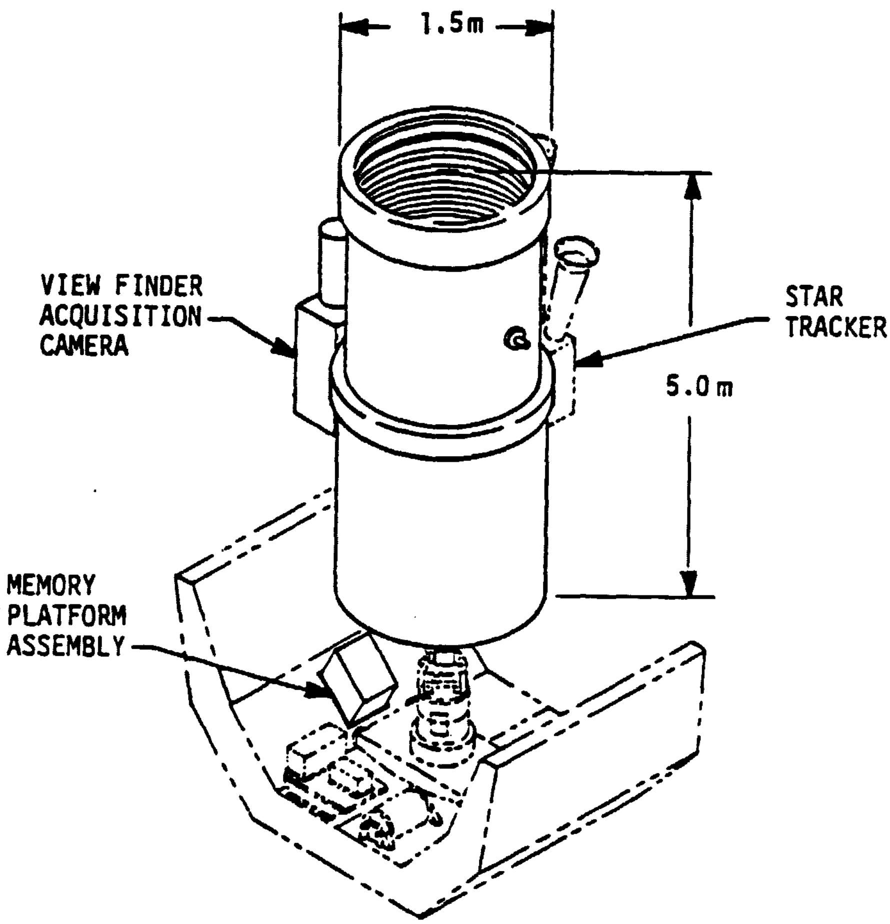
A change from Shuttle payload to station - attached P/L in 1992 is assumed.

Crew time includes some real-time target acquisition plus station processing of data (snapshot), and interaction with ground PI. The crew time and skill are derived, including consideration of international involvement with a number of PI. All crew-related data and payload durations are derived. Pallet-mounted weight and power are from Ref 2. Dimensions are derived from Ref 3. P/L requires station interface for active thermal control, using a freon loop (Ref 3). The payload element provides its own pointing.

Other data based on Ref 1, 2, and 3.

Code: GDCD 0000 PAYLOAD ELEMENT SYNTHESIS

From Ref 3.



Major Experiment Equipment and Consumables

Identification/Function	Qty	Wt (kg)	Dimension (m)		
			L	W	H
Telescope	1	1336	5	1.5*	
Camera Module Assembly	1	294			
Electronics Module Assembly	1	104			
Memory Platform Assembly	1	66			
Consumables:					
Total		1800	*diameter		

266.592-400

Code: GDCD 0000

PAYLOAD ELEMENT SYNTHESIS

From Ref 3.

ITEM	MASS (kg) UP/DOWN	POWER (W) OP./PEAK	ATC (W)	DATA (kbps)		
				SCI	STATUS	CMD
SCIENCE INSTRUMENTS:						
STARLAB	1800/1800	1400/1900	200	7000	2.0	0.5*
INTEGRATION HARDWARE:						
Signal Interface Unit (3)	30	75	75	-	TBD	TBD
Power Interface Unit (1)	40	50	50	-	TBD	TBD
Pointing System	470	370/1540	315	-	(2.0)	(0.5)*
Freon Pump Package	63	325	325	-	TBD	TBD
S/S Coldplate	14					
Experiment Coldplate	22					
CARRIER:						
Pallet	741					
Berthing Adapter Assembly	100					
PAYLOAD TOTAL	3280/3280	2220/3890	965	7000	(4.2)	(1.1)

* In command column indicates ancillary data.

( ) TBE estimate.

266.592-413

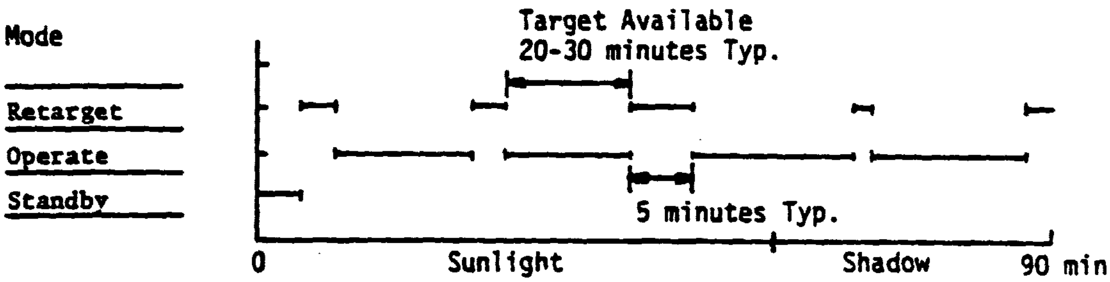
Table of Starlab Payload Characteristics

Code: GDCD 0000 PAYLOAD ELEMENT SYNTHESIS

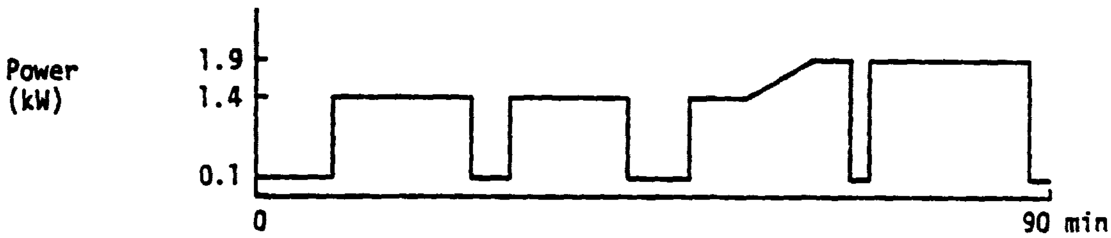
From Ref 3.

Operating Cycle Profiles

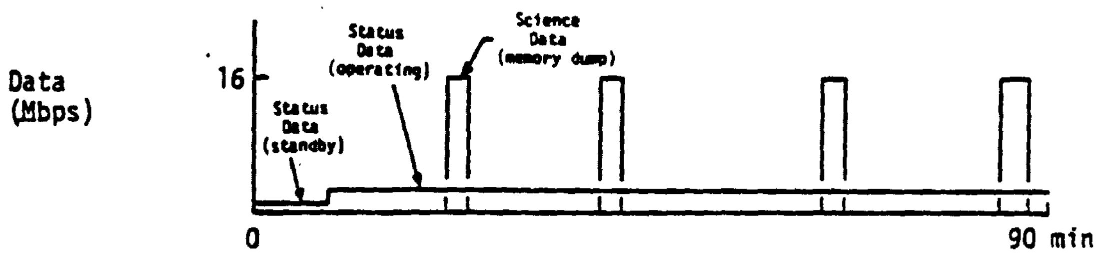
Activity Cycle: For a typical orbit identify type and duration of instrument activities (represent as bars). Describe relationship of activity to target availability, identifiable events, or special conditions (lighting, latitude, magnetic field, etc.).



Power Profile: Sketch in the power levels which correspond to the activities identified above.



Data Profile: Sketch in the data rates which correspond to the activities identified above.



Cycle Repetition (Describe considerations affecting cycle repetition): Target availability is primary driver. Typical exposure times range up to 45 minutes. Two to four targets per orbit is typical. Desire retargeting during orbit day or SAA passage. Objective is to have 2/3 of the time productive. Intermittent calibration sequences are required (order of once per day).

Is coordination with other instruments required? Yes ☐ No ☒
If so, describe:

266.592-401

Operating Cycle Profiles

PAYLOAD ELEMENT NAME LDR
Large Deployable Reflector

CODE G D C D 0 0 0 1

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☒ Planned
- ☐ Candidate
- ☐ Opportunity

First flight, yr 1998
No. of flights 1
Duration of Flight, days 2000

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 1

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 4

OBJECTIVE

To conduct infrared astronomical investigations for the study of a wide variety of astrophysical phenomena throughout the infrared spectral region.

DESCRIPTION

LDR will be brought to the Space Station on two Shuttle loads. It will be assembled and tested at the station. It gets placed in operational orbit by the OTV/TMS and is periodically serviced by the OTV/TMS.

CODE G D C D 0 0 0 1

ORBIT CHARACTERISTICS

Apogee, km 700 Perigee, km 700 Tolerance + ____ – ____

Inclination, deg 28.5 Tolerance + 21.5 – 0

Nodal Angle, deg ____ Ephemeris Accuracy, m ____

Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☒ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ____

Pointing accuracy, arc sec ____ Field of view, deg ____

Pointing Stability (Jitter) arc sec/sec ____

Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☐ Realtime ☐ Offline ☒ Other TDRSS Compatible

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____

☐ On-Board Data Processing Required

Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____

Film (Amount) ____ Voice (Hrs/Day) ____

Live TV (Hrs/Day) ____ Other ____

On-Board Storage (MBIT) ____

Data Dump Frequency (Per Orbit) ____

Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 0 0 0 1

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m 30 W,m 20 H,m 20 Deployed

Launch mass, kg 55,000

Consumables Types Cryogens

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☒ YES ☐ NO Reason Assy/Config Change Hrs/EVA 80

SERVICING/MAINTENANCE

SERVICE: Interval, days 720 Consumables, kg ______

Returnables, kg ______ Man Hours 8

CONFIGURATION CHANGES: Interval, day 1095 Man/Hrs Req. 40

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Training required for orbital assembly. Strong reasons required for greater than 28.5° orbital inclination. Design of the device at this time is quite nebulous. Two-man EVA assumed for assembly and configuration change; skill 7, level 1, and skill 6, level 2.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0001 ELEMENT NAME LARGE DEPLOYABLE REFLECTOR

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1998 INT. HRS ____ EVA HRS 40 EVA CREW 2

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 720 DAYS TOTAL SERVICES 2

☒ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE 8

☐ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

____ HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☒ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 1095 DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☐ NOT APPLICABLE EVA HRS PER RECONFIG. 40

EVA CREW SIZE 2

5. DEACTIVATION/REMOVAL

DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Reflector will be assembled at station and then deployed as a Free Flyer.
2. 2 Service Trips @ 8 hours each - TMS in situ service
4. 3 year configuration change
5. Operates beyond year 2000

TOTAL EVA HRS 80

Code: GDCD 0001

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Large Deployable Reflector (LDR)

Reference Documents:

1. Science and Applications Requirements for Space Station NASA Hq., p.11, RCVD 11/17/82

2. Astrophysics Project Concept Document, GDC Document No. 10-004N, October 1980

3. NASA TM-82482, MSFC, April 82

Narrative:

The free-flying accommodation is from Ref 1.

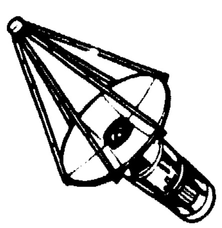
The launch date, duration, and crew-related requirements are derived. The weight for a 20-m reflector requiring man-assisted deployment is extrapolated from Ref 2, 12-meter reflector. Two shuttle launches are assumed.

It was assumed that the LDR is assembled in space station orbit by EVA. service is assumed to be compatible with TMS. Configuration change will be accomplished at the station by man (Ref 3) using EVA.

Remaining data based on Ref 1 and 2.

The LDR is envisioned as a complete spacecraft without self-propulsion.

From Ref 2.



Large Deployable Reflector

PAYLOAD ELEMENT NAME
Far UV Spectroscopy Explorer

CODE G D C D 0 0 0 2

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☒ Planned
- ☐ Candidate
- ☐ Opportunity

First flight, yr 1989
No. of flights 1
Duration of Flight, days 1825

OBJECTIVE

To carry out high- and low-resolution spectroscopy of distant matter in the 90-120 nanometers spectral range.

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 1

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 4

DESCRIPTION

The FUSE is being planned for a Shuttle launch and in ction into GEO orbit.

CODE G D C D 0 0 0 2 |

ORBIT CHARACTERISTICS

Apogee, km 35,786 Perigee, km 35,786 Tolerance + ____ - ____
Inclination, deg 28.5 Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☒ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec 2 Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak	2000	

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☒ Other TDRSS Compatible
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☒ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 40 Downlink Frequency (MHZ) ____

CODE G D C D 0 0 0 2

THERMAL
☐ Active ☐ Passive
Temperature, deg C operational min ______ max ______
non-operational min ______ max ______
Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS
Location: ☐ Internal ☐ External ☐ Remote
Equipment ID/Function ☐ Pressurized ☐ Unpressurized
L,m ______ W,m ______ H,m ______ Stowed
L,m ______ W,m ______ H,m ______ Deployed
Launch mass, kg 1360
Consumables Types ______
Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS
Crew Size ______ Task Assignment ______
Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE
SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______
CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Contamination sensitivity: Weight assumes Spacecraft provides apogee kick motor and stationkeeping propulsion.

GDCD CODE 0002 ELEMENT NAME FAR UV SPECTROSCOPY EXPLORER

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) ______ INT. HRS ______ EVA HRS ______ EVA CREW ______

☒ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ______ DAYS TOTAL SERVICES ______

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

______ HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☒ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Launched by Shuttle/upper stage in 1989
5. Spacecraft assumed to boost itself out of Geosynchronous orbit.

TOTAL EVA HRS 0

Code: GDCD 0002 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Far Ultraviolet Spectroscopy Explorer (FUSE)

Reference Documents:

1. Science and Applications Requirements for Space Station NASA Hq., p.10, RCVD 11/17/82

2. Astrophysics Project Concept Document, GDC Document No. 10-004J, October 1980

Narrative:

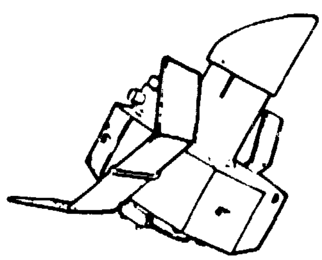
The Far Ultraviolet Spectroscopy Explorer (FUSE) is assumed to be best accomodated in the free-flying mode as sugested in Ref 1, with station-attached accommodations based on acceptable contamination countermeasures and pointing.

The pointing accuracy objective, description, and special considerations are from Ref 1.

Mission duration, mass, data generation rate, orbit, and sketch are from Ref 2.

Remaining data derived.

From Ref 2.



266.592-403

Far Ultraviolet Spectroscopy Explorer

PAYLOAD ELEMENT NAME
VY Long Baseline Interfer Demo

CODE G D C D 0 0 0 3

CONTACT
Name / Address: W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

TYPE
☒ Science & Applications (non-commercial)
☐ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 1

STATUS
☐ Operational
☐ Approved
☒ Planned
☐ Candidate
☐ Opportunity

First flight, yr 1995
No. of flights 1
Duration of Flight, days 1095

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 4

OBJECTIVE

To provide maps of compact celestial radio sources with finer resolution, less ambiguity, and more efficiency than earthbound VLB1 techniques.

DESCRIPTION

The very long baseline interferometry mission requires correlation of measurements with the ground. The orbiting portion is placed by the Shuttle. Servicing can be performed from a station controlled TMS. Cohabitation with the station is a possibility if pointing and contamination requirements can be met.

ORIGINAL PAGE IS
OF POOR QUALITY

CODE G D C D 0 0 0 3 — Page 2 of 3

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 4600 - 0
Inclination, deg 57 Tolerance + 0 - 28.5
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☒ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec 150 Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	900	
Standby		
Peak	1400	

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☒ Other TDRSS Compatible
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☒ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 12,000 Downlink Frequency (MHZ) ____

CODE G D C D 0 0 0 3

THERMAL

☒ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max 900
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 5 W,m 1.5 H,m 1.5 Stowed
L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 1354

Consumables Types Cryogens

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days 360 Consumables, kg 150
Returnables, kg ______ Man Hours 8

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

RFI Sensitive
Contamination
Pointing Stability
Target View Time

GDCD CODE 0003 ELEMENT NAME VERY LONG BASELINE INTERFEROMETRY DEMO

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1995 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 360 DAYS TOTAL SERVICES 2

   ☒ TMS/OTV ~~REQUIRED~~ ALTERNATE STATION HRS PER SERVICE 8

   ☐ NOT APPLICABLE EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ____ HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) 1998 INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

   This payload element assumes accommodation on a platform or modified Leasecraft-type spacecraft which has orbit transfer propulsion.

   2. 2 servicings via TMS or equivalent
   5. Shuttle/TMS/OTV Retrieval

TOTAL EVA HRS 0

Code: GDCD 0003 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Very Long Baseline Interferometry (VLBI) Demo

Reference Documents:

1. Science and Applications Requirements for Space Station, NASA Hq., p. 11, RCVD 11/17/82

2. Astrophysics Project Concepts Document, GDC Document No. 10-004Q, October 1980

3. Science and Applications Space Platform Payload Accommodations Study, SP82-MSFC-2583 p. A-25, March 1982

4. LANL Discussion, December 1982

5. Nominal Mission Model, Rev 6, MSFC PS01, 9/30/82

Narrative:

The VLBI payload element is assumed to be best accommodated (due to size and pointing) as a free-flyer (Ref 5), although station-attached accommodation is also suggested Ref 1.

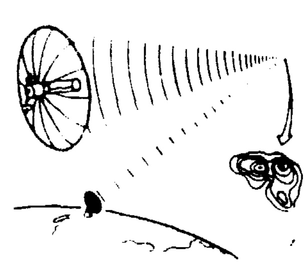
The weight is for instrumentation package and integration structure (pallet) and does not include propulsion system. A Leasecraft-type spacecraft could be added (modified for freon loop thermal control) to provide spacecraft resources and orbit transfer propulsion, platform accommodation.

The crew-related data and launch date are derived.

Remaining data based on Ref 1, 2, 3.

This payload element assumes accommodation on a platform or Leasecraft type spacecraft which has orbit transfer propulsion.

From Ref 2 for the Instrumentation Package.



266.592-404

Orbiting VLBI

PAYLOAD ELEMENT NAME
Space Telescope

CODE GDCD0004

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☒ Approved
- ☐ Planned
- ☐ Candidate
- ☐ Opportunity

First flight, yr 1992
No. of flights 1
Duration of Flight, days 1825

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 1

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 4

OBJECTIVE

To learn of the evolution of stars, of our and other galaxies; and to explore quasars, pulsars, gas clouds, and other planets.

DESCRIPTION

The Space Telescope (ST) will be in service for about 5 years before a station-based TMS will be available for ST servicing. The ST could be returned to earth for updating and refurbishment and replaced in orbit for service by the TMS from then on. The TMS could be used for periodic servicing.

ST Space Station support operations are assumed to begin in 1992.

CODE G D C D 0 0 0 4

ORBIT CHARACTERISTICS

Apogee, km 600 Perigee, km 600 Tolerance + ____ -
Inclination, deg 28.5 Tolerance + ____ -
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required,m/s ____

POINTING/ORIENTATION

View direction ☒ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy,arc sec ____ Field of view, deg ____
Pointing Stability (Jitter)arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage,V ____ Frequency,Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☒ Other TDRSS Compatible
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 0 0 0 4

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______
Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☐ Remote
Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 13.1 W,m 4.26 H,m 4.26 Stowed
L,m ______ W,m ______ H,m ______ Deployed
Launch mass, kg 11,600
Consumables Types ______
Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______
Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☒ YES ☐ NO Reason Configuration Change Hrs/EVA 64

SERVICING/MAINTENANCE

SERVICE: Interval, days 720 Consumables, kg ______
Returnables, kg ______ Man Hours 12
CONFIGURATION CHANGES: Interval, day 720 Man/Hrs Req. 40
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Very contamination sensitive. Best serviced in operational orbit. Bring to station for major refurbishment. Pointing stability for periods of 24 hours. Two-man EVA: skill 6, level 2; and skill 5, level 2 assumed for configuration changes.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0004 ELEMENT NAME SPACE TELESCOPE

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1992 INT. HRS ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 720 DAYS TOTAL SERVICES 2

☒ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE 12

☐ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

______ HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☒ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 720 DAYS TOTAL RECONFIGS. 2

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 8

☐ NOT APPLICABLE EVA HRS PER RECONFIG. 32

EVA CREW SIZE 2

5. DEACTIVATION/REMOVAL

DATE(S) 1997 INT. HRS. ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Space Telescope launched in 1985. Refurbished and relaunched for Space Station support in 1992.
4. TMS retrieval with EVA for reconfig.
5. Shuttle/TMS Retrieval

TOTAL EVA HRS 64

Code: GDCD 0004 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Space Telescope (ST)

Reference Documents:

1. Science and Applications Requirements for Space Station, NASA Hq., p. 10, RCVD 11/17/82
2. Nominal Mission Model, Rev 6, MSFC PS01, 9/30/82
3. NASA TM-82482, MSFC, April 82
4. LANL Discussions, Dec 1982

Narrative:

The free-flying accommodation is from Ref 1. Launch date is from Ref 2 for space station supported operations. An additional service was added in 1996. Configuration change is assumed to be accomplished at the station by man (Ref 3) using EVA. The spacecraft has no propulsion system (Ref 1). The crew-related data are derived.

Remaining data based on Ref 1.

The ST would probably continue as a national facility beyond the year 2000.

PAYLOAD ELEMENT NAME
Shuttle IR Telescope Facility

CODE
G D C D 0 0 0 5

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☒ Planned
- ☐ Candidate
- ☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 1825

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 1

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 6

OBJECTIVE

To conduct definitive high-sensitivity infrared photometric and spectroscopic studies of a wide range of astrophysical phenomena.

DESCRIPTION

Initially, the Shuttle infrared telescope facility (SIRTF) is to be a Shuttle mission. This limits operation to 14 days. Attempts should be made to have SIRTF a station resident, or serviced as a free flyer by the station-based TMS.

Assume reconfigured for Space Station operations beginning in 1990.

CODE G D C D 0 0 0 5

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 0 - 100
Inclination, deg 28.5 Tolerance + 28.5 - 0
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☒ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec ______ Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	1300	
Standby		
Peak	2735	

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☒ Other TDRSS Compatible
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 1000 Downlink Frequency (MHZ) ______

CODE G D C D 0 0 0 5

THERMAL

☒ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 11 W,m 4 H,m 4 Stowed
L,m 11 W,m 4 H,m 4 Deployed

Launch mass, kg 7018

Consumables Types Cryogenic Helium

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1 Task Assignment Operation

Skills (See Table B)

SKILL	6					
LEVEL	2					
Hrs/Day	0.5					

EVA ☒ YES ☐ NO Reason Service Hrs/EVA 36

SERVICING/MAINTENANCE

SERVICE: Interval, days 180 Consumables, kg ______
Returnables, kg ______ Man Hours 4

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Condensation contamination
Hot objects $\geq$ 60 degrees from FOV
Van Allen Rad sensitivity

GDCD CODE 0005 ELEMENT NAME SHUTTLE IR TELESCOPE FACILITY (SIRTF)

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER* ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1990 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 180 DAYS TOTAL SERVICES 9

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☐ NOT APPLICABLE ____ EVA HRS PER SERVICE 4

EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.5 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) 1995 INT. HRS. ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

* Free Flyer accommodation is an alternate mode, and if used will require re-evaluation of all requirements.

1. SIRTF launched in 1989. Reconfigured for station and attached in 1990.
2. Replace consumables (helium) every 6 mo.
3. Instrument control and monitoring
5. Remove and repackage for earth return (station OPS)

TOTAL EVA HRS 36

Code: GDCD 0005

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Shuttle IR Telescope Facility (SIRTF)

Reference Documents:

1. Science and Applications Requirements for Space Station, NASA Hq., p.11, RCVD 11/17/82
2. Astrophysics Project Concept Document, GDC Document No. 10-004L, October 1980
3. LANL Discussions, December 1982

Narrative:

The SIRTF is assumed to be reconfigured for Station operations in 1990. The Station-attached accommodation mode was selected from among alternatives listed in Ref 1 and 2. The basis of this recommended mode is to reduce spacecraft or TMS cryogenic cooling service trips. Since the Shuttle-based SIRTF will have developed suitable countermeasures for contamination (restricted operations) it is assumed that the attached accommodation will be cost-effective.

The SIRTF will provide a pointing system (IPS), Ref 2. Length is estimated and includes IPS.

The crew will start and monitor operation, assisted by ground-based astronomers, Ref (2). The crew-related data and mission launch/duration data are derived.

Remaining data based on Ref 1 and 2.

PAYLOAD ELEMENT NAME
Gamma Ray Observatory

CODE G D C D 0 0 3 0

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☒ Approved
- ☐ Planned
- ☐ Candidate
- ☐ Opportunity

First flight, yr 1988
No. of flights ____
Duration of Flight, days 1865

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 1

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 6

OBJECTIVE

Detection of Gamma Ray lines from Supernovae, their remnants, and the interstellar medium.

DESCRIPTION

The Gamma Ray observation (GRO) originally designed to be a free flyer, could be serviced by a station-based TMS, or be a station resident.

CODE G D C D 0 0 3 0

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 50 - 50
Inclination, deg 0 Tolerance + 28.5 - 0
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction [x] Inertial [ ] Solar [ ] Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec 60 Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

[ ] AC [ ] DC

	Power, W	Duration, hrs/day
Operating	200	
Standby		
Peak		

[ ] Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
[ ] None [x] Realtime [x] Offline [x] Other TDRSS Compatible
[ ] Encryption/Decryption Required
[ ] Uplink Req.: Command Rate (KBS) 5 Frequency (MHZ) ______
[x] On-Board Data Processing Required
Description ______

Data Types: [ ] Analog [ ] Digital [ ] Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

CODE G D C D 0 0 3 0

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min ________ max ________
non-operational min ________ max ________

Heat Rejection, w operational min ________ max ________
non-operational min ________ max ________

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ________ W,m ________ H,m ________ Stowed
L,m ________ W,m ________ H,m ________ Deployed
Launch mass, kg 11,000
Consumables Types ________
Acceleration sensitivity, g min ________ max ________

CREW REQUIREMENTS

Crew Size ________ Task Assignment ________

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☒ YES ☐ NO Reason Service Hrs/EVA 12

SERVICING/MAINTENANCE

SERVICE: Interval, days 360 Consumables, kg ________
Returnables, kg ________ Man Hours 8

CONFIGURATION CHANGES: Interval, day ________ Man/Hrs Req. ________
Deliverables, kg ________ Returnables, kg ________

SPECIAL CONSIDERATIONS/See Instructions

Naturally occuring radioactivity in materials on the station and materials with high atomic number should not be in proximity.

GDCD CODE 0030 ELEMENT NAME GAMMA RAY OBSERVATORY (GRO)

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) ______ INT. HRS ______ EVA HRS ______ EVA CREW ______

   ☒ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 365 DAYS TOTAL SERVICES 3

   ☒ TMS/OTV ~~REQUIRED~~ ALTERNATE — STATION HRS PER SERVICE 8

   ☐ NOT APPLICABLE — EVA HRS PER SERVICE 4

   EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ______ HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ______ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED — STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE — EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) 1993 INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

   This payload element has orbit transfer propulsion.

   1. Payload launched by shuttle in 1988.
   2. Three service trips, 1990, 1991, 1992 via TMS or equivalent and EVA

TOTAL EVA HRS 12

Code: GDCD 0030

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Gamma Ray Observatory (GRO)

Reference Documents:

1. Science and Applications Requirements for Space Station, NASA Hq., p.11, RCVD 11/17/82
2. Nominal Mission Model, Rev 6, MSFC PS01, 9/30/82
3. LANL Discussions, December 1982

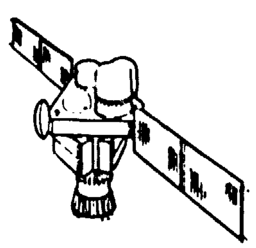
Narrative:

The GRO is designed and deployed in orbit in 1988 prior to the Space Station/TMS era. It is assumed that the TMS will have capability to retrieve the GRO for service at the station, or the GRO could return to the station using spacecraft propulsion. In either event, servicing at the station is assumed vs in-situ servicing due to potential incompatibility with TMS.

The launch date and weight are from Ref 2, and the mission duration is estimated. The crew-related data are derived.

Remaining data based on Ref 1.

Derived space-maintainable concept:



266.592-405

Gamma Ray Observatory

Code: GDCD 0031

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: High Throughput Mission (HTM)

Reference Documents:

1. Science and Applications Requirements for Space Station, NASA Hq., p. 14, REVD 11/17/82

Narrative:

Station-attached accomodation is assumed for the HTM. Crew-related requirements are derived.

Flight dates and duration are assumed; however, this payload element could continue operating after the year 2000.

The remaining data are based on Ref (1) which uses Large Area Modular Array (LAMAR) as representative requirements for HTM.

PAYLOAD ELEMENT NAME
High Throughput Mission

CODE G D C D 0 0 3 1

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 1999
No. of flights 1
Duration of Flight, days 1460

TYPE

☒ Science & Applications (non-commercial)
☐ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 1

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

OBJECTIVE

To investigate high energy processes in astrophysical systems, including the very compact sources associated with black holes and neutron stars.

DESCRIPTION

HTM is an X-ray telescope that obtains good resolution by trading off mirror quality for quantity. It is a good candidate for a Space Station resident facility, and could benefit from the station facilities and manual attention. Duration can continue beyond 2000.

CODE G D C D 0 0 3 1

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + -
Inclination, deg 28.5 Tolerance + -
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☒ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec 180 Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	2000	
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☒ Other TDRSS Compatible
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☒ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 125 Downlink Frequency (MHZ) ____

CODE G D C D 0 0 3 1

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 10,000

Consumables Types Detector Gas

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1

Skills (See Table B) Task Assignment Operation

SKILL	6					
LEVEL	2					
Hrs/Day	1					

EVA ☒ YES ☐ NO Reason Service Hrs/EVA 36

SERVICING/MAINTENANCE

SERVICE: Interval, days 360 Consumables, kg ______

Returnables, kg ______ Man Hours 12

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Strong X-ray sources.

GDCD CODE 0031 ELEMENT NAME HIGH THROUGHPUT MISSION

ACCOMODATION: [X] ATTACHED [ ] FREE FLYER* [ ] OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1999 INT. HRS ______ EVA HRS ______ EVA CREW ______

[ ] NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 360 DAYS TOTAL SERVICES 3

[ ] TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

[ ] NOT APPLICABLE ______ EVA HRS PER SERVICE 12

EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

1.0 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

[ ] NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

[ ] TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

[X] NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

[X] NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

* Free Flyer accommodation is an alternate mode, and if used will require re-evaluation of all requirements.

1. Attachment to station considered station OPS.
2. 3 Service EVA's - replace det. gas
3. Instrument control and monitoring
5. Remains attached beyond year 2000

TOTAL EVA HRS 36

Code: GDCD 0032

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Large Area Modular Array (LAMAR)

Reference Documents:

1. Science and Applications Requirements for Space Station, NASA Hq., p. 14, RCVD 11/17/82

2. Astrophysics Project Concept Document, GDC Document No. 10-004E, October 1980

3. Science and Applications Space Platform Payload Accommodations Study SP82-MSFC-2583, p. A-51, March 1982

4. LANL Discussions, December 1982

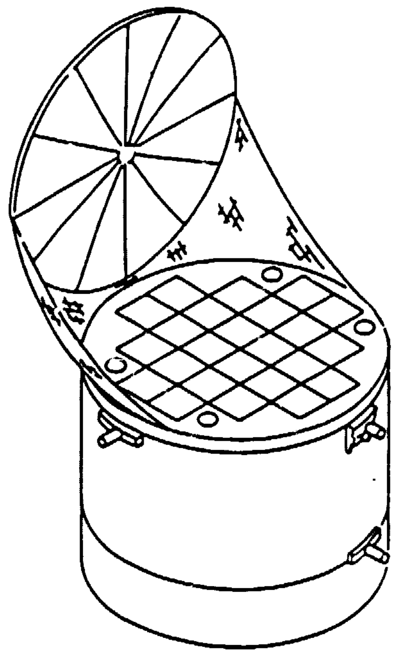
Narrative:

Station-attached accommodation is assumed for LAMAR. Launch weight is from Ref 3.

Crew-related requirements and service requirements are derived.

Remaining data based on Ref 1, 2, and 3.

From Ref 3.



266.592-406

PAYLOAD ELEMENT NAME
Large Area Modular Array

CODE
G D C D 0 0 3 2

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone: (619) 277-8900, Ext. 3778/2130

STATUS

- [ ] Operational
- [ ] Approved
- [x] Planned
- [ ] Candidate
- [ ] Opportunity

First flight, yr 1994
No. of flights 1
Duration of Flight, days 1640

TYPE

- [x] Science & Applications (non-commercial)
- [ ] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A) 1

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

OBJECTIVE

To conduct an all-sky survey of discrete X-ray sources and diffuse features with very high sensitivity and angular resolution.

DESCRIPTION

LAMAR consists of 84 coaligned X-ray telescopes assembled in modular arrays. The mission makes an excellent station candidate because of the replenishment of expendable, and inherent maintenance required. Also, the manual operation enhances the capability of life span of the facility.

CODE G D C D 0 0 3 2

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + -

Inclination, deg 28.5 Tolerance + -

Nodal Angle, deg ______ Ephemeris Accuracy, m ______

Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☒ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ______

Pointing accuracy, arc sec 180 Field of view, deg 2

Pointing Stability (Jitter) arc sec/sec 60° Sun, 20° Earth, 5° Galactic Equator

Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	3400	
Standby		
Peak		

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☒ Realtime ☒ Offline ☒ Other TDRSS Compatible

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______

☒ On-Board Data Processing Required

Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______

Film (Amount) ______ Voice (Hrs/Day) ______

Live TV (Hrs/Day) ______ Other ______

On-Board Storage (MBIT) ______

Data Dump Frequency (Per Orbit) ______

Recording Rate (KBPS) 125 Downlink Frequency (MHZ) ______

CODE GDCD0032

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ____ max ____
non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 3.4 W,m 4.42 H,m 4.42 Stowed
L,m 7.82 W,m 4.42 H,m 4.42 Deployed

Launch mass, kg 9516

Consumables Types X_E/CH_4 Detector Gas

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 1

Task Assignment Operation

Skills (See Table B)

SKILL	6					
LEVEL	2					
Hrs/Day	0.5					

EVA ☒ YES ☐ NO Reason Service Hrs/EVA 64

SERVICING/MAINTENANCE

SERVICE: Interval, days 360 Consumables, kg ____
Returnables, kg ____ Man Hours 16

CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Avoidance of strong X-ray sources.
Cryogenics also required for detectors.

GDCD CODE 0032 ELEMENT NAME LARGE AREA MODULAR ARRAY (LAMAR)

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER* ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1994 INT. HRS ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 360 DAYS TOTAL SERVICES 4

   ☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

   ☐ NOT APPLICABLE ______ EVA HRS PER SERVICE 16

   EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.5 HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ______ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) 1999 INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

   * Free Flyer accommodation is an alternate mode, and if used will require re-evaluation of all requirements.

   1. Attachment to station considered station OPS
   2. 4 service EVA's - replace det. gas
   3. Instrument control and monitoring
   5. Removal/return to earth considered station OPS

TOTAL EVA HRS 64

PAYLOAD ELEMENT NAME
Adv. X-Ray Astrophy Facility (AXAF)

CODE G D C D 0 0 3 3

TYPE

- [X] Science & Applications (non-commercial)
- [ ] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A) 1

CONTACT
Name
Address

W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- [ ] Operational
- [ ] Approved
- [X] Planned
- [ ] Candidate
- [ ] Opportunity

First flight, yr 1991
No. of flights 1
Duration of Flight, days 3600

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 4

OBJECTIVE

To extend previous results in X-ray astronomy research in the areas of source location and structure, spectroscopy, polarimetry, and temporal behavior.

SCRIPTION

AXAF will be a Shuttle launched and maintainable national X-ray telescope facility with advanced capabilities in energy range, sensitivities, angular resolution, instrument complement, mission lifetime and target accessibility. It is designed for a 10 to 15 year life with update and servicing initially by the orbiter and becomes a prime candidate for station-based TMS update and servicing with major refurbishment taking place at the station rather than return to earth.

CODE GDCD0033

ORBIT CHARACTERISTICS

Apogee, km 500 Perigee, km 500 Tolerance + ______ - ______

Inclination, deg 28.5 Tolerance + ______ - ______

Nodal Angle, deg ______ Ephemeris Accuracy, m ______

Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☒ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ______

Pointing accuracy, arc sec 30 Field of view, deg ______

Pointing Stability (Jitter) arc sec/sec ______

Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☐ Realtime ☐ Offline ☒ Other IDRSS Compatible

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______

☐ On-Board Data Processing Required

Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______

Film (Amount) ______ Voice (Hrs/Day) ______

Live TV (Hrs/Day) ______ Other ______

On-Board Storage (MBIT) ______

Data Dump Frequency (Per Orbit) ______

Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

CODE G D C D 0 0 3 3

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 12.8 W,m 4.3 H,m 4.3 Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 10,267

Consumables Types Cryogenics

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☒ YES ☐ NO Reason Configuration Change Hrs/EVA 128

SERVICING/MAINTENANCE

SERVICE: Interval, days 720 Consumables, kg 8

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day 720 Man/Hrs Req. 40

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Contamination sensitive. Designed to be serviced in orbit. Data dump rate 32 kbps. Two-man crew assumed for configuration change: skill 6, level 2; and skill 5, level 2.

GDCD CODE 0033 ELEMENT NAME ADVANCED X-RAY ASTROPHYSICS FACILITY (AXAF)

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1991 INT. HRS ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 720 DAYS TOTAL SERVICES 4

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE 8

☐ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

______ HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☒ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 720 DAYS TOTAL RECONFIGS. 4

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 8

☐ NOT APPLICABLE EVA HRS PER RECONFIG. 32

EVA CREW SIZE 2

5. DEACTIVATION/REMOVAL

DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

2. 4 service trips, 1993, 1995, 1997, 1999
4. Reconfig. slated to coincide with service trips
5. Remains active beycnd year 2000

TOTAL EVA HRS 128

Code: GDCD 0033

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Advanced X-Ray Astrophysics Facility (AXAF)

Reference Documents:

1. Science and Applications Requirements for Space Station, NASA Hq., p. 14, RCVD 11/17/82
2. Nominal Mission Model, Rr ˉ, 'SFC PS01, 9/30/82
3. NASA TM-82482, MSFC, April
4. Astrophysics Project Concept Document, GDC Document No. 10-004D, October 1980
5. LANL Discussions, December 1982

Narrative:

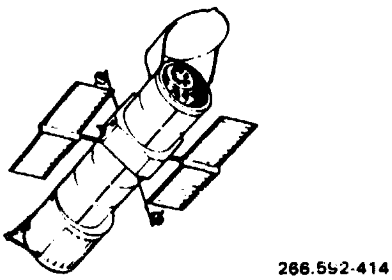
The free-flying accommodation is from Ref 1. The spacecraft does not contain orbit transfer propulsion system

Launch and schedule are from Ref (2) modified for constant 2-year service interval (versus 2- and 3-year service intervals).

Configuration change is assumed to be accomplished at the station by man (Ref 3) using EVA.

Remaining data based in Ref 1 and 4.

From Ref 4.



Advanced X-Ray Astrophysics Facility

PAYLOAD ELEMENT NAME
High Resolution X & Y-Ray Spectrum

CODE G D C D 0 0 3 4

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1993
No. of flights 1
Duration of Flight, days 1080

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 1

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 7

OBJECTIVE

To obtain high-energy resolution measurements of cosmic X-ray and Gamma-Ray emission.

DESCRIPTION

The high resolution X-ray and Gamma-Ray spectrometer facility has been examined from the point of view of a free flyer and as an attached mission on the station. All things being normalized it would appear most feasible as a station attachment.

CODE G D C D 0 0 3 4

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + -
Inclination, deg 28.5 Tolerance + -
Nodal Angle, deg ___ Ephemeris Accuracy, m ___
Escape dV Required, m/s ___

POINTING/ORIENTATION

View direction ☒ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ___
Pointing accuracy, arc sec 360 Field of view, deg 3 - 10° FWHM
Pointing Stability (Jitter) arc sec/sec ___
Special Restrictions (Avoidance) ___

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	530	
Standby		
Peak	830	

☐ Continuous

Voltage, V ___ Frequency, Hz ___

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☒ Other TDRSS Compatible
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ___ Frequency (MHZ) ___
☒ On-Board Data Processing Required
Description ___

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ___
Film (Amount) ___ Voice (Hrs/Day) ___
Live TV (Hrs/Day) ___ Other ___
On-Board Storage (MBIT) ___
Data Dump Frequency (Per Orbit) ___
Recording Rate (KBPS) 30 Downlink Frequency (MHZ) ___

CODE G D C D 0 0 3 4

THERMAL

[X] Active [ ] Passive

Temperature, deg C — operational min ____ max ____
non-operational min ____ max ____

Heat Rejection, w — operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: [ ] Internal [ ] External [ ] Remote

Equipment ID/Function [ ] Pressurized [ ] Unpressurized

L,m 2.1 W,m 2.1 H,m 2.1 Stowed
L,m 2.1 W,m 2.1 H,m 2.1 Deployed

Launch mass, kg 1768

Consumables Types Argon & Solid CO_2

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 1

Task Assignment Operation

Skills (See Table B)

SKILL	6					
LEVEL	2					
Hrs/Day	0.5					

EVA [X] YES [ ] NO Reason Service Hrs/EVA 60

SERVICING/MAINTENANCE

SERVICE: Interval, days 180 Consumables, kg ____
Returnables, kg ____ Man Hours 12

CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Proximity of natural radioactivity and materials with high atomic number is undesirable.

GDCD CODE 0034 ELEMENT NAME HI RESOLUTION X-RAY & GAMMA RAY SPECTROMETER

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER* ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1993 INT. HRS ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 180 DAYS TOTAL SERVICES 5

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

☐ NOT APPLICABLE ______ EVA HRS PER SERVICE 12

EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.5 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) 1996 INT. HRS. ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

*Free Flyer accommodation is an alternate mode, and if used will require re-evaluation of all requirements.

1. Attached to station. Considered station OPS
2. Service @ 6 mo. - replace gas
3. Instrument control and monitoring
5. Removal and return to Earth-Station OPS

TOTAL EVA HRS 60

Code: GDCD 0034

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: High Resolution X-Ray and Gamma-Ray Spectrometer (HRS)

Reference Documents:

1. Science and Applications Requirements for Space Station, NASA Hq., p. 14, RCVD 11/17/82

2. Science and Applications Space Platform Payload Accommodations Study, SP-82-MSFC-2583, p. A-50, March 1982

3. LANL Discussions, December 1982

Narrative:

From among the options listed in Ref 1, the HRS is assumed to be best accommodated in a station-attached mode.

The crew-related data and launch/mission data are derived.

The remaining data are based on Ref 1 and 2. Dimensions include an estimate for the pointing mount.

PAYLOAD ELEMENT NAME
High Energy Isotope Experiment (HEIE)

CODE
G D C D 0 0 3 5

CONTACT
Name / Address: W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1997
No. of flights 1
Duration of Flight, days 1100

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 1

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 4

OBJECTIVE

To search for rare nuclei and exotic particles like magnetic monopoles and to measure the composition of ultra-heavy nuclei.

DESCRIPTION

If the HEIE is selected as a free-flyer, it will be placed in a 57 degree (or higher) orbit by the Shuttle, and periodically (about 6-month intervals) servicing will be required and could be handled from a station orbiting at the same inclination. Cosmic ray investigations have the least restrictive pointing and contamination requirements of any astrophysics discipline and should be easily accommodated in an attached mode.

CODE G D C D 0 0 3 5

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 35 - 30
Inclination, deg 57 Tolerance + -
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec 3600 Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	300	
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☒ Other TDRSS Compatible
☐ Encryption/Decryption Required
☒ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☒ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE GDCD0035

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min ____ max ____
non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m ____ W,m ____ H,m ____ Stowed

L,m ____ W,m ____ H,m ____ Deployed

Launch mass, kg 3000

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 1

Task Assignment Operations

Skills (See Table 2)

SKILL	6					
LEVEL	2					
Hrs/Day	0.5					

EVA ☒ YES ☐ NO Reason Service Hrs/EVA 40

SERVICING/MAINTENANCE

SERVICE: Interval, days 180 Consumables, kg ____

Returnables, kg ____ Man Hours 8

CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____

Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Orientation = Anti-earth.

Inclination greater than 57 degrees acceptable.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GOCD CODE 0035 ELEMENT NAME HIGH ENERGY ISOTOPE EXPERIMENT (HEIE)

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER * ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1997 INT. HRS ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 180 DAYS TOTAL SERVICES 5

   ☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

   ☐ NOT APPLICABLE ______ EVA HRS PER SERVICE 8

   EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.5 HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ______ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) 2000 INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

*Free Flyer accommodation is an alternate mode, and if used will require re-evaluation of all requirements.

1 & 5 are considered as station OPS

TOTAL EVA HRS 40

Code: GDCD 0035

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: High Energy Isotope Experiment (HEIE)

Reference Documents:

1. Science and Applications Requirements for Space Station, NASA Hq., p. 17, RCVD 11/17/82

Narrative:

The attached accommodation mode is assumed for HEIE as suggested by Ref (1).

The orbit of 57 degrees (or greater) is from Ref 1.

Remaining data derived.

PAYLOAD ELEMENT NAME
Spectra of Cosmic Ray Nuclei (SCRN)

CODE G D C D 0 0 3 6

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone: (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1996
No. of flights 1
Duration of Flight, days 365

OBJECTIVE

To help explain the characteristics and distributions of galactic cosmic-ray sources and the mechanism of cosmic-ray propagation through interstellar space.

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 1

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

DESCRIPTION

Although SCRN was conceived to be used at an inclination of 57 degrees, attaching ic to the manned station provides sufficient over-riding benefits to stay on the station and operate at 28.5 degrees contamination and pointing should be easily satisfied. The flight duration could be made variable, dependent on data gathered rather than expendable depletion.

CODE GDCD0036

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 35 - 30
Inclination, deg 57 Tolerance + 0 - 28.5
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec 3600 Field of view, deg 140
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	731	
Standby		
Peak	785	

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☒ Other TDRSS Compatible
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☒ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 102 Downlink Frequency (MHZ) ______

CODE G D C D 0 0 3 6

THERMAL

☒ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 3.28 W,m 4.78 H,m 3.78 Stowed

L,m 3.28 W,m 4.78 H,m 3.78 Deployed

Launch mass, kg 3082

Consumables Types Ne, CO_2, Freon

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1

Task Assignment Operation/Maintenance

Skills (See Table B)

SKILL	6					
LEVEL	2					
Hrs/Day	0.2					

EVA ☒ YES ☐ NO Reason Service Hrs/EVA 8

SERVICING/MAINTENANCE

SERVICE: Interval, days 180 Consumables, kg ______

Returnables, kg ______ Man Hours 8

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Earth pointing required for calibration.
Orientation = Anti-earth.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0036 ELEMENT NAME SPECTRA OF COSMIC RAY NUCLEI

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER * ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1995 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 180 DAYS TOTAL SERVICES 1

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☐ NOT APPLICABLE ____ EVA HRS PER SERVICE 8

   EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.2 HRS PER DAY (INTERNAL

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) 1998 INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

*Free Flyer accommodation is an alternate mode, and if used will require re-evaluation of all requirements.

1. Attached to station. Considered station OPS
2. Replace Ne, CO_2, FREON
3. Instrument control and monitoring
5. Removal/return considered station OPS

TOTAL EVA HRS 8

Code: GDCD 0036 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Spectra of Cosmic Ray Nuclei (SCRN)

Reference Documents:

1. Science and Applications Requirements for Space Station, NASA Hq., p. 17, RCVD 11/17/82

2. Science and Applications Space Platform Accommodation Study SP82-MSFC-2583, p A-37, March 1982

Narrative:

SCRN is assumed to be accommodated in the station-attached mode, continuing the present short-duration space lab accommodation.

The launch mission data orientation and crew related data are derived.

Remaining data based on Ref 1 and 2.

PAYLOAD ELEMENT NAME
Transition Radiation & Ion Cal

CODE G D C D 0 0 3 7

TYPE
- [x] Science & Applications (non-commercial)
- [ ] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A) 1

CONTACT
Name / Address: W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- [ ] Operational
- [ ] Approved
- [ ] Planned
- [x] Candidate
- [ ] Opportunity

First flight, yr 1996
No. of flights 1
Duration of Flight, days 700

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

OBJECTIVE

To observe electrons, protons, and helium nuclei to determine if there is a major change in the composition of cosmic-rays.

DESCRIPTION

The transition radiation and ionization calorimeter experiment is an outgrowth of a Spacelab experiment. Long observation times improve its capability by a factor of ten. It would make a good candidate for a station resident experiment, since pointing accuracy and contamination are not primary factors.

CODE GDCD0037

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 35 - 30

Inclination, deg 57 Tolerance + 0 - 28.5

Nodal Angle, deg ____ Ephemeris Accuracy, m ____

Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ____

Pointing accuracy, arc sec 3600 Field of view, deg ____

Pointing Stability (Jitter) arc sec/sec ____

Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	550	
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☐ Realtime ☐ Offline ☐ Other TDRSS Compatible

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____

☒ On-Board Data Processing Required

Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____

Film (Amount) ____ Voice (Hrs/Day) ____

Live TV (Hrs/Day) ____ Other ____

On-Board Storage (MBIT) ____

Data Dump Frequency (Per Orbit) ____

Recording Rate (KBPS) 10 Downlink Frequency (MHZ) ____

CODE G D C D 0 0 3 7

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed
L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 5750

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1

Task Assignment Operation, Maintenance

Skills (See Table B)

SKILL	6					
LEVEL	2					
Hrs/Day	0.5					

EVA ☒ YES ☐ NO Reason Servicing Hrs/EVA 9

SERVICING/MAINTENANCE

SERVICE: Interval, days 180 Consumables, kg ______

Returnables, kg ______ Man Hours 3

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Orientation = Anti-earth.

GDCD CODE 0037 ELEMENT NAME TRANSITION RADIATION & ION CALORIMETER (TRIC)

ACCOMODATION: [X] ATTACHED [ ] FREE FLYER * [ ] OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1996 INT. HRS ____ EVA HRS ____ EVA CREW ____

[ ] NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 180 DAYS TOTAL SERVICES 3

[ ] TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

[ ] NOT APPLICABLE ____ EVA HRS PER SERVICE 3

EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.5 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

[ ] NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

[ ] TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

[X] NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) 1998 INT. HRS. ____ EVA HRS ____ EVA CREW ____

[ ] NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

*Free Flyer accommodation is an alternate mode, and if used will require re-evaluation of all requirements.

1. Attached to station. Considered station OPS

3. Instrument control and monitoring
5. Removal/return considered station OPS

TOTAL EVA HRS 9

Code: GDCD 0037

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Transition Radiation and ION Calorimeter (TRIC)

Reference Documents:

1. Science and Applications Requirements for Space Station, NASA Hq., p. 17, RCVD 11/17/82

Narrative:

TRIC is assumed to be accomodated in the space station attached mode based on an extension of spacelab experiment with more stringent requirements.

The power and weight data, as well as mission objectives and description, are from Ref 1.

Remaining data derived. An anti-earth orientation was selected for instrument pointing.

PAYLOAD ELEMENT NAME
X-Ray Timing Explorer (XTE)

CODE G D C D 0 0 3 8

TYPE
- [x] Science & Applications (non-commercial)
- [ ] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A) 1

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-3900, Ext. 3778/2130

STATUS
- [ ] Operational
- [ ] Approved
- [x] Planned
- [ ] Candidate
- [ ] Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 720

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 7

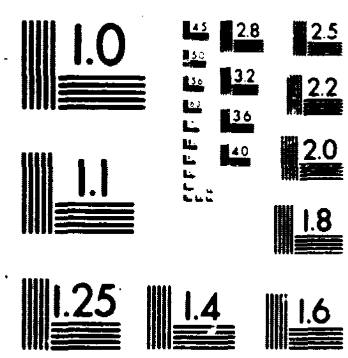
OBJECTIVE

To study the temporal variability in X-ray emitting objects.

DESCRIPTION

The XTE is currently planned as a Shuttle-launched free flyer.

N84-21005 UNCLAS



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

CODE G D C D 0 0 3 8

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + -

Inclination, deg 28.5 Tolerance + -

Nodal Angle, deg ______ Ephemeris Accuracy, m ______

Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☒ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ______

Pointing accuracy, arc sec 36 Field of view, deg ______

Pointing Stability (Jitter) arc sec/sec ______

Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak	1200	

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☒ Realtime ☒ Offline ☒ Other TDRSS Compatible

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______

☒ On-Board Data Processing Required

Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______

Film (Amount) ______ Voice (Hrs/Day) ______

Live TV (Hrs/Day) ______ Other ______

On-Board Storage (MBIT) ______

Data Dump Frequency (Per Orbit) ______

Recording Rate (KBPS) 10 Downlink Frequency (MHZ) ______

C-2

CODE G D C D 0 0 3 8

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 1 W,m 2 H,m 2 Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 1000

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

GDCD CODE 0038 ELEMENT NAME X-RAY TIMING EXPLORER

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1990 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

____ HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☒ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) 1992 INT. HRS. ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

This payload element has orbit transfer propulsion.

2. No scheduled service. Station is available for emergency service.
5. Shuttle/TMS removal and return to Earth.

TOTAL EVA HRS 0

Code: GDCD 0038 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: X-Ray Timing Explorer (XTE)

Reference Documents:

1. Space Station NAAO Study Orientation Meeting, NASA Hq., 14-15 September 1982

2. Astrophysics Project Concept Document, GDC Document No. 10-004C-2, October 1980

3. LANL Discussions, December 1982

Narrative:

The XTE is a shuttle launched, free-flying payload element per Ref 2.

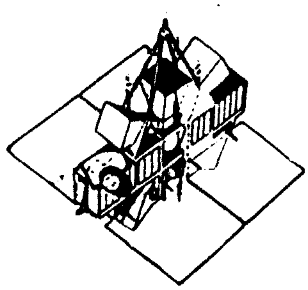
The spacecraft is designed with an on-board propulsion system, using hydrazine.

The mission duration, orbit, pointing accuracy, power, weight and TDRSS requirements are from Ref 2.

Remaining data derived.

Initial launch shown as 1988 in Ref 1; however, an additional launch is assumed in the 1990 decade.

From Ref 2.



266.592-407

X-Ray Timing Explorer

PAYLOAD ELEMENT NAME
Solar Internal Dynamics Mission (SIDM)

CODE G D C D 0 0 6 0

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1991
No. of flights 1
Duration of Flight, days 360

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 1

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 2

OBJECTIVE

To obtain data about the internal structure and dynamics of the sun.

DESCRIPTION

The orbit requirements of the SIDM suggests a free flyer with possible service controlled by the Space Station.

CODE G D C D 0 0 6 0

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + ____ - ____

Inclination, deg 99 ____ Tolerance + ____ - ____

Nodal Angle, deg ____ Ephemeris Accuracy, m ____

Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☒ Solar ☐ Earth

Truth Sites (if known) ____

Pointing accuracy, arc sec 2 ____ Field of view, deg ____

Pointing Stability (Jitter) arc sec/sec ____

Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	200	
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☒ Realtime ☐ Offline ☐ Other TDRSS Compatible

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____

☒ On-Board Data Processing Required

Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____

Film (Amount) ____ Voice (Hrs/Day) ____

Live TV (Hrs/Day) ____ Other ____

On-Board Storage (MBIT) ____

Data Dump Frequency (Per Orbit) ____

Recording Rate (KBPS) 650 ____ Downlink Frequency (MHZ) ____

CODE G D C D 0 0 6 0

THERMAL

☐ Active ☒ Passive

Temperature, deg C — operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w — operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed
L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 4540

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Hydrocarbon contamination.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0060 ELEMENT NAME SOLAR INTERNAL DYNAMICS MISSION (SIDM)

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1991 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ____ HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) 1992 INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

   This payload element has orbit transfer propulsion.

   1. Placed in orbit by shuttle or ELV
   5. Removal via shuttle/TMS

TOTAL EVA HRS 0

Code: GDCD 0060 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Solar Internal Dynamics Mission (SIDM)

Reference Documents:

1. Science and Applications Requirements for Space Station, NASA Hq., p. 19, RCVD 11/17/82

2. Nominal Mission Model, Rev 6, MSFC PS01, 9/30/82

Narrative:

SIDM requires a sun-synchronous orbit (Ref 1). A free-flyer accomodation was assumed based on Ref 2.

The spacecraft weight is from Ref 2 and assumes orbit transfer provided propulsion.

The pointing, power, thermal control data generation rate, and service interval are from the typical characteristics shown in Ref 1.

Remaining data derived.

PAYLOAD ELEMENT NAME
Solar Corona Diagnostics Mission (SCDM)

CODE GDCD0061

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☒ Planned
- ☐ Candidate
- ☐ Opportunity

First flight, yr 1993
No. of flights 1
Duration of Flight, days 360

OBJECTIVE
To determine the cause of solar corona heating.

TYPE
- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 1

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 7

DESCRIPTION
The SCDM has been envisioned as a possible free flyer. The SCDM should be studied as a station resident experiment operated and maintained by the station personnel.

CODE G D C D 0 0 6 1

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + ___ - ___

Inclination, deg 28.5 Tolerance + ___ - ___

Nodal Angle, deg ___ Ephemeris Accuracy, m ___

Escape dV Required, m/s ___

POINTING/ORIENTATION

View direction ☐ Inertial ☒ Solar ☐ Earth

Truth Sites (if known) ___

Pointing accuracy, arc sec 2 Field of view, deg ___

Pointing Stability (Jitter) arc sec/sec ___

Special Restrictions (Avoidance) ___

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	200	
Standby		
Peak		

☐ Continuous

Voltage, V ___ Frequency, Hz ___

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☒ Realtime ☐ Offline ☒ Other TDRSS Compatible

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ___ Frequency (MHZ) ___

☒ On-Board Data Processing Required

Description ___

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ___

Film (Amount) ___ Voice (Hrs/Day) ___

Live TV (Hrs/Day) ___ Other ___

On-Board Storage (MBIT) ___

Data Dump Frequency (Per Orbit) ___

Recording Rate (KBPS) 650 Downlink Frequency (MHZ) ___

CODE G D C D 0 0 6 1

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min ____ max ____

non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____

non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ____ W,m ____ H,m ____ Stowed

L,m ____ W,m ____ H,m ____ Deployed

Launch mass, kg 1800

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size ____ Task Assignment ____

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ____ Hrs/EVA ____

SERVICING/MAINTENANCE

SERVICE: Interval, days ____ Consumables, kg ____

Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____

Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Hydrocarbon contamination.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0061 ELEMENT NAME SOLAR CORONA DIAGNOSTICS MISSION (SCDM)

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1993 INT. HRS ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ______ DAYS TOTAL SERVICES ______

   ☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

   ☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

   EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ______ HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ______ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) 1994 INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

   5. Shuttle/TMS retrieved

TOTAL EVA HRS 0

Code: GDCD 0061 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Solar Corona Diagostics Mission (SCDM)

Reference Documents:

1. Science and Applications Requirements for Space Station, NASA Hq., p. 19, RCVD 11/17/82

2. Nominal Mission Model, Rev 6, MSFC PS01, 9/30/82

Narrative:

SCDM is assumed to be accommodated as a free-flyer.

The weight is from Ref 2 and is assumed to include orbit transfer propulsion.

The pointing, power, thermal control, data generation rate, and service interval are from the typical characteristics shown in Ref 1.

Remaining data derived.

PAYLOAD ELEMENT NAME
Advanced Solar Observatory (ASO)

CODE
G D C D 0 0 6 2

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

☐ Operational
☐ Approved
☒ Planned
☐ Candidate
☐ Opportunity

First flight, yr 1995
No. of flights 1
Duration of Flight, days 2900

OBJECTIVE

To carry individual instruments capable of examining solar phenomena that can be pointed to regions of interest on the solar disc or throughout its atmosphere.

TYPE

☒ Science & Applications (non-commercial)

☐ Commercial

☐ Technology Development

☐ Operations

Type Number (see Table A) 1

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 3

DESCRIPTION

The ASO consists of the extreme ultra-violet telescope, the solar soft X-ray telescope, pin hole/occulter, and the solar optical telescope. The 57 degree inclination pushes it toward being a free flyer. Periodic maintenance and refurbishment can be performed by a station based OTV. Other options include final assembly and checkout at the station prior to placement in operational orbit.

CODE GDCD0062

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 35 - 30
Inclination, deg 57 Tolerance + 0 - 28.5
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☒ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	4100	
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☒ Other TDRSS Compatible
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 42,000 Downlink Frequency (MHZ) ____

CODE G D C D 0 0 6 2

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 8.2 W,m 3.8 H,m 3.8 Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 12,500

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days 730 Consumables, kg ______

Returnables, kg ______ Man Hours 8

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

If the majority of experiments could be performed at 28.5 degrees it makes a good candidate for station occuption. Real time manual remote operation is desirable.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0062 ELEMENT NAME ADVANCED SOLAR OBSERVATORY

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1995 INT. HRS ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 720 DAYS TOTAL SERVICES 3

   ☒ TMS/OTV ~~REQUIRED~~ Alternate STATION HRS PER SERVICE 8

   ☐ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

   EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ______ HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ______ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

   This payload element assumes accommodation on a platform or Leasecraft type spacecraft which has orbit transfer propulsion.

   5. Will remain in use past year 2000

TOTAL EVA HRS 0

Code: GDCD 0062

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Advanced Solar Observatory (ASO)

Reference Documents:

1. Science and Applications Requirements for Space Station, NASA Hq., p. 20, RCVD 11/17/82
2. Science and Applications Space Platform Payload Accommodations Study, SP82-MSFC-2503 p. A-67, March 1982
3. LANL Discussion, December 1982

Narrative:

A free-flying accommodation is assumed primarily due to orbit inclination requirements although a station attached option is also suggested in Ref 1.

The crew-related data, launch and mission data, and special considerations are derived.

Remaining data from Ref (2).

The observatory as defined in Ref (2) is without supporting subsystems or orbit transfer propulsion and would require a Leasecraft-type spacecraft or alternatively platform accommodation.

The sketch is from Ref (2), with typical instruiments from Ref (1) as follows:

SSXRTF = Solar soft x-ray telescope facility
SXUVTF = Solar extreme UV telescope facility
SOT = Solar optical telescope
P/OF = pinhole/occulter facility (not shown)

Although specific reconfiguration is not shown, the long life of this national facility suggests periodic changes of telescope instruments.

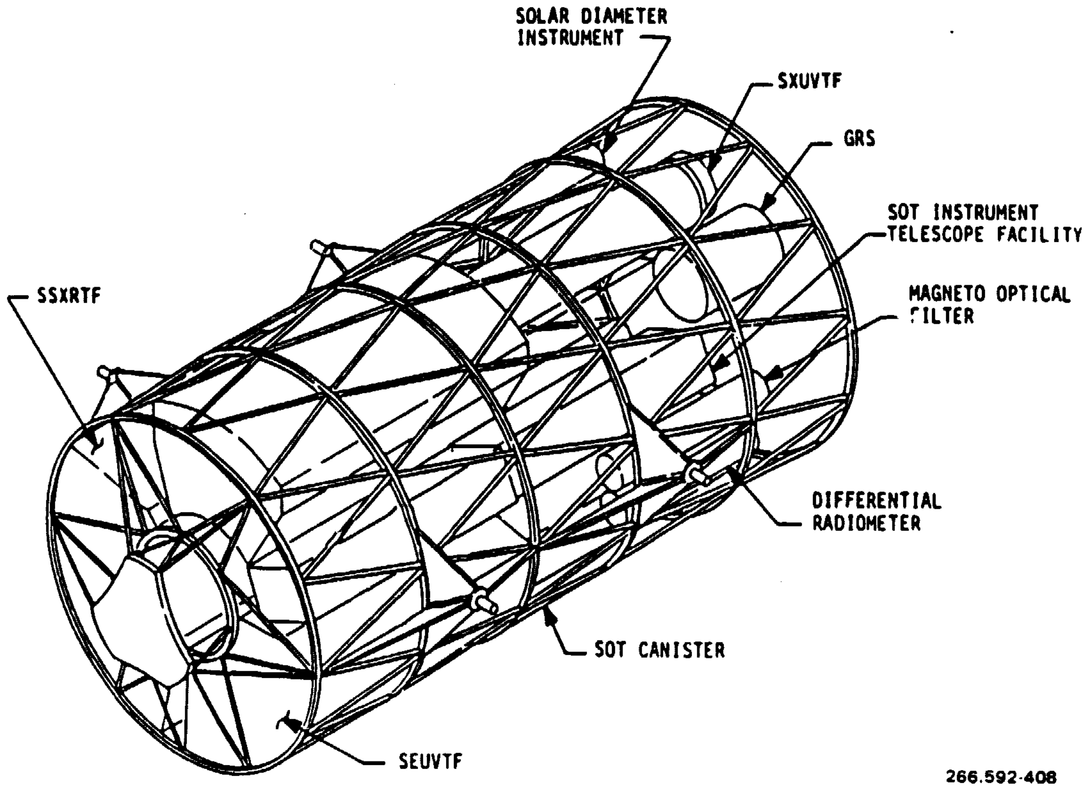
This payload element assumes accommodation on a platform or Leasecraft type spacecraft which has orbit transfer propulsion.

ORIGINAL PAGE IS OF POOR QUALITY

Code: GDCD 0062

PAYLOAD ELEMENT SYNTHESIS

From Ref 2.



Advanced Solar Observatory

Section 1.2

Discipline Earth and Planetary Exploration

GDCD ID NO.	PAYLOAD ELEMENT NAME
	PLANETARY OBSERVATIONS
0103	Mars Geochemistry/Climatology Orbiter
0104	Mars Aeronomy Orbiter
0105	Venus Atmosphere Probe
0106	Lunar Geochemistry Orbiter
0107	Titan Probe
0108	Saturn Orbiter
0109	Mars Lander
0110	Saturn Probe
	SOLAR SYSTEM MISSIONS
0121	Comet T2 Rendezvous
0122	Main-Belt Asteroid Rendezvous
0123	Comet HMP Sample Return
0124	Near-Earth Asteroid Rendezvous
	EARTH DYNAMICS
	No payload elements identified in this Discipline.
	CRUSTAL MOTION
0151	Detection and Monitoring of Episodic Events
0152	Geoscience - Crustal Dynamics Studies
	GEOPOTENTIAL FIELDS
0161	Earth Science Research - Geophysical Investigation
	EARTH RESOURCES
0171	Renewable Resources - Earth Science Research

Section 1.2 (Continued)

Discipline Earth and Planetary Exploration

GDCD ID NO.	PAYLOAD ELEMENT NAME
0172	Operational Land Systems
0173	Shuttle Active Microwave Experiment (SAMEX-C)
0174	Earth Observations Instrument Development (Microwave Technology)
0175	Earth Observations Instrument Development (Extra Visible & Broad RF)
0176	EO Sensor/Techniques/Analysis/Automated System Development
0177	Geoscience-Geology Remote Sensing
0178	Reserved
1079	Imaging Radar for Earth Resources Inventory & Monitoring
0180	Freeflying Imaging Radar Experiment (FIREX)
0181	Z-Continuous Coverage
0182	Z-Hydrologic Cycle Priority
0183	Z-Special Coverage
0184	Z-Continuous and Special Coverage

PAYLOAD ELEMENT NAME
Mars Geochem/Climatol Orbiter

CODE
G D C D 0 1 0 3

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☒ Planned
- ☐ Candidate
- ☐ Opportunity

First flight, yr 1992
No. of flights 1
Duration of Flight, days 1

OBJECTIVE

To characterize the surface composition, magnetic field, topography, and gravity of the planet and define the seasonal volatiles history of the atmosphere as well as overall climate.

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 2

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

DESCRIPTION

An orbiting spacecraft, with a broad and integrated set of geophysical and geochemical sensors, is an essential element in the exploration of Mars. Studies of the planetary interior, surface, atmosphere, and plasma environment all depend heavily on data acquired from orbit. The unique contribution of the orbiter is its ability to characterize the planet on a global basis.

CODE G D C D 0 1 0 3 Page 2 of 3

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ______ - ______
Inclination, deg 28.5 Tolerance + ______ - ______
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s 3380

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec ______ Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☒ None ☐ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

CODE GDCD0103

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 5600

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2 Task Assignment ______

Skills (See Table B)

SKILL	7	7				
LEVEL	3	2				
Hrs/Day	4	4				

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Station involvement with Spacecraft ends with launch from LEO into escape trajectory. A ground data link is required for prelaunch checkout. No communication required after launch. No servicing required.

GDCD CODE 0103 ELEMENT NAME MARS GEOCHEMISTRY/CLIMATOLOGY ORBITER

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1992 INT. HRS ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ______ DAYS TOTAL SERVICES ______

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

8 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

3. Station involvement is for mating of spacecraft with upper stage (OTV or equivalent) using RMS or equivalent. Station could store spacecraft until ready for mating. Involvement ends with launch from LEO into escape trajectory. No station resources are required, however a spacecraft-to-ground data link is required for checkout. Two men required (4 hours each) for 1 day.

TOTAL EVA HRS 0

Code: GDCD 0103

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Mars Geochemistry/Climatology Orbiter

Reference Documents:

1. MSFC Letter, D. Saxton To Boeing and GDC, "Planetary Mission Requirements for OTV," 7/30/79

2. Paper, Astronautics and Aeronautics Journal, Jesse W. Moore (NASA), "Effective Planetary Exploration at Low Cost," Oct 1982

3. S.A.I. Report No. SAI 1-120-340-T19, Sept 1982; Telecon, J. Neihoff, Oct 1982

4. MSFC, Solar System Exploration Scenario, Sept 1982; GDC Visit, Oct 1982

5. JPL Internal Memo, A.Y. Nakata, "Mariner Mark II Preliminary Mission Requirements Report," Rev 2, 10/1/82; GDC Visit, Oct 1982

6. Solar System Exploration Committee Recommended Core Program, Nov 1982

Narrative:

This payload element is recommended in the Ref 6 program, judged to be most authorative planning document on planetary and solar system exploration available at this time. The objectives and rationale were obtained from Ref 5. Technical data are given in Ref 3, pp 43-45. Crew requirements and station operations were derived. The importance of the space station to the mission was rated a "5" because the payload could be launched from the shuttle with existing upper stage vehicles. However, the availability of a space station does permit bringing the spacecraft to LEO well in advance of escape launch, reducing reliance on the availability of a shuttle during the launch window.

Ref 1, 2 and 4 also identify this mission.

PAYLOAD ELEMENT NAME
Mars Aeronomy Orbiter

CODE G D C D 0 1 0 4

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☒ Planned
- ☐ Candidate
- ☐ Opportunity

First flight, yr 1992
No. of flights 1
Duration of Flight, days 1

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 2

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

OBJECTIVE

To survey the upper atmosphere and solar wind interaction, as well as the magnetic field of the planet.

DESCRIPTION

This mission augments the Mars geochemistry/climatology orbiter in the unmanned exploration of the planet. It will provide global coverage plus a time history of the dynamics of the planet's upper atmosphere and magnetic field.

CODE G D C D 0 1 0 4

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ______ - ______
Inclination, deg 28.5 Tolerance + ______ - ______
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s 3380

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec ______ Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☒ None ☐ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

CODE G D C D 0 1 0 4

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 5600

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2

Task Assignment ______

Skills (See Table B)

SKILL	7	7				
LEVEL	3	2				
Hrs/Day	4	4				

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Station involvement with Spacecraft ends with launch from LEO into escape trajectory. A ground data link is required for prelaunch checkout. No communication required after launch. No servicing required.

GDCD CODE 0104 ELEMENT NAME MARS AERONOMY ORBITER

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1992 INT. HRS ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ______ DAYS TOTAL SERVICES ______

   ☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

   ☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

   EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   8 HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ______ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

   3. Station involvement is for mating of spacecraft with upper stage (OTV or equivalent) using RMS or equivalent. Station could store spacecraft until ready for mating. Involvement ends with launch from LEO into escape trajectory. A spacecraft-to-ground data link is required for checkout.
   Two men required (4 hours each) for 1 day.

TOTAL EVA HRS 0

Code: GDCD 0104

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Mars Aeronomy Orbiter

Reference Documents:

1. MSFC Letter, D. Saxton To Boeing and GDC, "Planetary Mission Requirements for OTV," 7/30/79

2. Paper, Astronautics and Aeronautics Journal, Jesse W. Moore (NASA), "Effective Planetary Exploration at Low Cost," Oct 1982

3. S.A.I. Report No. SAI 1-120-340-T19, Sept 1982; Telecon, J. Neihoff, Oct 1982

4. MSFC, Solar System Exploration Scenario, Sept 1982; GDC Visit, Oct 1982

5. JPL Internal Memo, A.Y. Nakata, "Mariner Mark II Preliminary Mission Requirements Report," Rev 2, 10/1/82; GDC Visit, Oct 1982

6. Solar System Exploration Committee Recommended Core Program, Nov 1982

Narrative:

This payload element is recommended in the Ref 6 program, judged to be most authorative planning document on planetary and solar system exploration available at this time. The objectives and rationale were obrained from Ref 5. Technical data are given in Ref 3, pp 43-45. Crew requirements and station operations were derived. The importance of the space station to the mission was rated a "5" because the payload could be launched from the shuttle with existing upper stage vehicles. However, the availability of a space station does permit bringing the spacecraft to LEO well in advance of escape launch, reducing reliance on the availability of a shuttle during the launch window.

Ref 1, 2 and 4 also identify this mission.

PAYLOAD ELEMENT NAME
Venus Atmosphere Probe

CODE
G D C D 0 1 0 5

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1993
No. of flights 1
Duration of Flight, days 1

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 2

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

OBJECTIVE

To determine the concentration of photochemically active gases and investigate the composition and formation of atmospheric aerosols.

DESCRIPTION

The harsh Venusian environment has thus far yielded only limited information on the planets atmospheric structure and dynamics. The Venus atmosphere probe mission is directed by enhancement of this knowledge through improved capability to endure the ambient conditions and superior instrumentation to sense and transmit critical data.

CODE G D C D 0 1 0 5

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ____ -

Inclination, deg 28.5 Tolerance + ____ -

Nodal Angle, deg ____ Ephemeris Accuracy, m ____

Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ____

Pointing accuracy, arc sec ____ Field of view, deg ____

Pointing Stability (Jitter) arc sec/sec ____

Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:

☒ None ☐ Realtime ☐ Offline ☐ Other ____

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____

☐ On-Board Data Processing Required

Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____

Film (Amount) ____ Voice (Hrs/Day) ____

Live TV (Hrs/Day) ____ Other ____

On-Board Storage (MBIT) ____

Data Dump Frequency (Per Orbit) ____

Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 0 1 0 5

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed
L,m ______ W,m ______ H,m ______ Deployed
Launch mass, kg 6000
Consumables Types ______
Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2 Task Assignment ______

Skills (See Table B)

SKILL	7	7				
LEVEL	3	2				
Hrs/Day	4	4				

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Station involvement with Spacecraft ends with launch from LEO into escape trajectory. A ground data link is required for prelaunch checkout. No communication required after launch. No servicing required.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0105 ELEMENT NAME VENUS ATMOSPHERE PROBE

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1993 INT. HRS ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ______ DAYS TOTAL SERVICES ______

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

8 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

3. Station involvement is for mating of spacecraft with upper stage (OTV or equivalent) using RMS or equivalent. Station could store spacecraft until ready for mating. Involvement ends with launch from LEO into escape trajectory. No station resources are required, however a spacecraft-to-ground data link is required for checkout. Two men required (4 hours each) for 1 day.

TOTAL EVA HRS 0

Code: GDCD 0105 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Venus Atmosphere Probe

Reference Documents:

1. Solar System Exploration Committee Recommended Core Program, Nov 1982

2. NASA Lunar and Planetary Mission Handbook, Volume IV, May 1979

Narrative:

This is a recommended mission in the Ref 1 program. An additional Venus mission, the Venus radar mapper, is also one of the recommended missions but is planned in the pre-space-station time frame, It was therefore not included as a payload in this study. Ref 2, sections VLB and VSR, was used for mission objectives and background information.

Crew requirements and station operations were derived. The importance of the space station to the mission was rated a "5" because the payload could be launched from the shuttle with existing upper stage vehicles. However the availability of a space station does permit bringing the spacecraft to LEO well in advance of escape launch, reducing reliance on the availability of a shuttle during the launch window.

PAYLOAD ELEMENT NAME
Lunar Geochemistry Orbiter

CODE GDCD0106

TYPE
☒ Science & Applications (non-commercial)
☐ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 2

CONTACT
Name / Address: W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 1993
No. of flights 1
Duration of Flight, days 1

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 5

OBJECTIVE

To characterize the surface composition, topography, and gravity of earth's moon.

DESCRIPTION

The Moon is now viewed as a representative of a large class of planetary objects. It is one of a number of intermediate-size bodies, and it is grouped with objects of intermediate density that include Io and Europa, but it is clearly separated from denser Mercury and larger Mars. Because density is closely related to bulk composition, the Moon is an important compositional representative of a class of solar system objects. Thus, the Moon offers us an accessible laboratory for studying similar planetary processes.

A basic point in the scientific rationale for a lunar polar orbiter mission is that the Earth-Moon system is, and will remain for the foreseeable future, the tie-point for planetological comparisons. This is true because we have information about these bodies that will be obtainable for most other planets in any approaching the depth of that available for the Earth and Moon.

CODE GDCD0106

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ____ - ____

Inclination, deg 28.5 Tolerance + ____ - ____

Nodal Angle, deg ____ Ephemeris Accuracy, m ____

Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ____

Pointing accuracy, arc sec ____ Field of view, deg ____

Pointing Stability (Jitter) arc sec/sec ____

Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:

☒ None ☐ Realtime ☐ Offline ☐ Other ____

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____

☐ On-Board Data Processing Required

Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____

Film (Amount) ____ Voice (Hrs/Day) ____

Live TV (Hrs/Day) ____ Other ____

On-Board Storage (MBIT) ____

Data Dump Frequency (Per Orbit) ____

Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE GDCD0106

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 480

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2 Task Assignment ______

Skills (See Table B)

SKILL	7	7				
LEVEL	3	2				
Hrs/Day	4	4				

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Station involvement with Spacecraft ends with launch from LEO into escape trajectory. A ground data link is required for prelaunch checkout. No communication required after launch. No servicing required.

GOCD CODE 0106 ELEMENT NAME LUNAR GEOCHEMISTRY ORBITER

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1993 INT. HRS ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ______ DAYS TOTAL SERVICES ______

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

8 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

3. Station involvement is for mating of spacecraft with upper stage (OTV or equivalent) using RMS or equivalent. Station could store spacecraft until ready for mating. Involvement ends with launch from LEO into escape trajectory. No station resources are required, however a spacecraft-to-ground data link is required for checkout. Two men required (4 hours each) for 1 day.

TOTAL EVA HRS 0

Code: GDCD 0106

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Lunar Geochemistry Orbiter

Reference Documents:

1. Paper, Astronautics and Aeronautics Journal, Jesse W. Moore (NASA), "Effective Planetary Exploration at Low Cost," Oct 1982

2. Solar System Exploration Committee Recommended Core Program, Nov 1982

3. NASA Lunar and Planetary Mission Handbook, Volume IV, May 1979

Narrative:

This is a recommended mission in the Ref 2 program. Program objectives and description were obtained from Ref 3 section LPO. The launch date in the payload sheets is arbitrary since a launch opportunity occurs every month. Ref 1 also identifies this as a recommended mission.

Crew requirements and station operations were derived. The importance of the space station to the mission was rated a "5" because the payload could be launched from the shuttle with existing upper stage vehicles. However the availability of a space station does permit bringing the spacecraft to LEO well in advance of escape launch, reducing reliance on the availability of a shuttle during the launch window.

PAYLOAD ELEMENT NAME
Titan Probe

CODE G D C D 0 1 0 7

TYPE
- [x] Science & Applications (non-commercial)
- [ ] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A) 2

CONTACT
Name
Address

W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- [ ] Operational
- [ ] Approved
- [ ] Planned
- [x] Candidate
- [ ] Opportunity

First flight, yr 1995
No. of flights 1
Duration of Flight, days 1

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

OBJECTIVE

To determine the chemical composition of the atmosphere of Saturn's moon, Titan, and characterize the physical state and homogeneity of its surface.

DESCRIPTION

Titan's atmosphere represents a composition which probably comes closest to the primordial atmosphere of earth. The nature of the surface and precise chemical composition of the lower atmosphere are unknown. An instrumented probe is best suited to provide this information.

CODE GDCD0107

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ______ - ______
Inclination, deg 28.5 Tolerance + ______ - ______
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dv Required, m/s 7390

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec ______ Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ______ - ______ Frequency, Hz ______ - ______

DATA/COMMUNICATIONS

Monitoring requirements:
☒ None ☐ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

CODE G D C D 0 1 0 7 Page 3 of 3

THERMAL
☐ Active ☐ Passive
Temperature, deg C operational min ______ max ______
non-operational min ______ max ______
Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS
Location: ☐ Internal ☒ External ☐ Remote
Equipment ID/Function ☐ Pressurized ☒ Unpressurized
L,m ______ W,m ______ H,m ______ Stowed
L,m ______ W,m ______ H,m ______ Deployed
Launch mass, kg 960
Consumables Types ______
Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS
Crew Size 2 Task Assignment ______
Skills (See Table B)

SKILL	7	7				
LEVEL	3	2				
Hrs/Day	4	4				

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE
SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______
CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Station involvement with Spacecraft ends with launch from LEO into escape trajectory. A ground data link is required for prelaunch checkout. No communication required after launch. No servicing required.

GDCD CODE 0107 ELEMENT NAME TITAN PROBE

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1995 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

8 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

3. Station involvement is for mating of spacecraft with upper stage (OTV or equivalent) using RMS or equivalent. Station could store spacecraft until ready for mating. Involvement ends with launch from LEO into escape trajectory. No station resources are required, however a spacecraft-to-ground data link is required for checkout. Two men required (4 hours each) for 1 day.

TOTAL EVA HRS 0

Code: GDCD 0107

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Titan Probe

Reference Documents:

1. MSFC Letter, D. Saxton to Boeing and GDC, "Planetary Mission Requirements for OTV," 7/30/79

2. Paper, Astronautics and Aeronautics Journal, Jesse W. Moore (NASA), "Effective Planetary Exploration at Low Cost," Oct 1982

3. S.A.I. Report No. SAI 1-120-340-T19, Sept 1982; Telecon, J. Neihoff, Oct 1982

4. MSFC, Solar System Exploration Scenario, Sept 1982; GDC Visit, Oct 1982

5. JPL Internal Memo, A.Y. Nakata, "Mariner Mark II Preliminary Mission Requirements Report," Rev 2, 10/1/82; GDC Visit, Oct 1982

6. Solar System Exploration Committee Recommended Core Program, Nov 1982

Narrative:

This is a recommended mission in the Ref 6 program. Program objectives and description were obtained from Ref 5 section 2.6. Technical data are given in Ref 3, pp 89 and 90.

Crew requirements and station operations were derived. The importance of the space station to the mission was rated a "5" because the payload could be launched from the shuttle with existing upper stage vehicles. However the availability of a space station does permit bringing the spacecraft to LEO well in advance of escape launch, reducing reliance on the availability of a shuttle during the launch window.

Ref 1, 2 and 4 also identify this mission.

PAYLOAD ELEMENT NAME
Saturn Orbiter

CODE G D C D 0 1 0 8

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1997
No. of flights 1
Duration of Flight, days 1

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 2

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

OBJECTIVE

To characterize the dynamic behavior of the assembly of satellites, field, and rings which comprise this complex planet system.

DESCRIPTION Voyager missions provided instantaneous glimpses of the Saturn system. An orbiter mission is required to understand the dynamics of this complex assembly of satellites, field phenomena, rings, and giant planet. This mission will orbit a Spacecraft about Saturn for long duration study. The mission will feature repeated close encounters with Titan, the only large body in the solar system with a nitrogen atmosphere, except for Earth. A better understanding of Titan's atmosphere will provide basic information on how Titan evolved and allow a unique comparison and insight into Earth's evolution.

CODE GDCD0108

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ____ - ____
Inclination, deg 28.5 Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☒ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE GDCD0108

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ____ max ____

non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____

non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ____ W,m ____ H,m ____ Stowed

L,m ____ W,m ____ H,m ____ Deployed

Launch mass, kg 1800

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 2 Task Assignment ____

Skills (See Table B)

SKILL	7	7				
LEVEL	3	2				
Hrs/Day	4	4				

EVA ☐ YES ☒ NO Reason ____ Hrs/EVA ____

SERVICING/MAINTENANCE

SERVICE: Interval, days ____ Consumables, kg ____

Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____

Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Station involvement with Spacecraft ends with launch from LEO into escape trajectory. A ground data link is required for prelaunch checkout. No communication required after launch. No servicing required.

GDCD CODE 0108 ELEMENT NAME SATURN ORBITER

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1997 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   8 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

   3. Station involvement is for mating of spacecraft with upper stage (OTV or equivalent) using RMS or equivalent. Station could store spacecraft until ready for mating. Involvement ends with launch from LEO into escape trajectory. No station resources are required, however a spacecraft-to-ground data link is required for checkout. Two men required (4 hours each) for 1 day.

TOTAL EVA HRS 0

Code: GDCD 0108

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Saturn Orbiter

Reference Documents:

1. MSFC Letter, D. Saxton to Boeing and GDC, "Planetary Mission Requirements for OTV," 7/30/79

2. Paper, Astronautics and Aeronautics Journal, Jesse W. Moore (NASA), "Effective Planetary Exploration at Low Cost," Oct 1982

3. S.A.I. Report No. SAI 1-120-340-T19, Sept 1982; Telecon, J. Neihoff, Oct 1982

4. MSFC, Solar System Exploration Scenario, Sept 1982; GDC Visit, Oct 1982

5. JPL Internal Memo, A.Y. Nakata, "Mariner Mark II Preliminary Mission Requirements Report," Rev 2, 10/1/82; GDC Visit, Oct 1982

6. Solar System Exploration Committee Recommended Core Program, Nov 1982

Narrative:

This is a recommended mission in the Ref 6 program. Objectives and description used material from Ref 5, Section 2.7.

Crew requirements and station operations were derived. The importance of the space station to the mission was rated a "5" because the payload could be launched from the shuttle with existing upper stage vehicles. However the availability of a space station does permit bringing the spacecraft to LEO well in advance of escape launch, reducing reliance on the availability of a shuttle during the launch window.

Ref 1, 2, 3, and 4 also identify this mission.

PAYLOAD ELEMENT NAME
Mars Lander

CODE G D C D 0 1 0 9

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1997
No. of flights 1
Duration of Flight, days 1

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 2

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

OBJECTIVE

To determine the bulk composition, surface structure, and weather of the planet.

DESCRIPTION

This mission will augment the Mars orbiters with detail measurements at the planet's surface.

CODE GDCD0109

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ____ - ____
Inclination, deg 28.5 Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	____	____
Standby	____	____
Peak	____	____

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☒ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE GDCD0109

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed
L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 1700
Consumables Types ______
Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2 Task Assignment ______

Skills (See Table B)

SKILL	7	7				
LEVEL	3	2				
Hrs/Day	4	4				

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Station involvement with Spacecraft ends with launch from LEO into escape trajectory. A ground data link is required for prelaunch checkout. No communication required after launch. No servicing required.

GDCD CODE 0109 ELEMENT NAME MARS LANDER

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1997 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   8 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

   3. Station involvement is for mating of spacecraft with upper stage (OTV or equivalent) using RMS or equivalent. Station could store spacecraft until ready for mating. Involvement ends with launch from LEO into escape trajectory. No station resources are required, however a spacecraft-to-ground data link is required for checkout. Two men required (4 hours each) for 1 day.

TOTAL EVA HRS 0

Code: GDCD 0109

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Mars Lander

Reference Documents:

1. Solar System Exploration Committee Recommended Core Program, Nov 1982

2. NASA Lunar and Planetary Mission Handbook, Volume IV, May 1979

Narrative:

This is a recommended mission in the Ref 1 program. Launch opportunities to Mars occur approximately yearly (Ref 2, Section MSR). The 1997 launch date is therefore somewhat arbitrary. It was selected late in the decade since two Mars orbiters were scheduled in the 1992 time frame.

Crew requirements and station operations were derived. The importance of the space station to the mission was rated a "5" because the payload could be launched from the shuttle with existing upper stage vehicles. However the availability of a space station does permit bringing the spacecraft to LEO well in advance of escape launch, reducing reliance on the availability of a shuttle during the launch window.

PAYLOAD ELEMENT NAME
Saturn Probe

CODE G D C D 0 1 1 0

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone: (619) 277-8900, Ext. 3778/2130

STATUS

☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 1997
No. of flights 1
Duration of Flight, days 1

TYPE

☒ Science & Applications (non-commercial)
☐ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 2

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

OBJECTIVE

Determine temperature, pressure, density, and chemical composition of the atmosphere. Determine the location and structure of clouds. Characterize the upper atmosphere and the ionosphere.

DESCRIPTION

This mission will augment the Saturn orbiter in providing detail in-situ measurements of the Saturn system. The probe will complete the picture of the structure and dynamics of Saturn's atmosphere down to a very low altitude.

CODE G D C D 0 i 1 0

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ____ - ____

Inclination, deg 28.5 Tolerance + ____ - ____

Nodal Angle, deg ____ Ephemeris Accuracy, m ____

Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ____

Pointing accuracy, arc sec ____ Field of view, deg ____

Pointing Stability (Jitter) arc sec/sec ____

Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	____	____
Standby	____	____
Peak	____	____

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:

☒ None ☐ Realtime ☐ Offline ☐ Other ____

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____

☐ On-Board Data Processing Required

Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____

Film (Amount) ____ Voice (Hrs/Day) ____

Live TV (Hrs/Day) ____ Other ____

On-Board Storage (MBIT) ____

Data Dump Frequency (Per Orbit) ____

Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 0 1 1 0

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed
L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 2170

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2

Skills (See Table B) Task Assignment

SKILL	7	7				
LEVEL	3	2				
Hrs/Day	4	4				

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Station involvement with Spacecraft ends with launch from LEO into escape trajectory. A ground data link is required for prelaunch checkout. No communication required after launch. No servicing required.

GOCD CODE 0110 ELEMENT NAME SATURN PROBE

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1997 INT. HRS ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ______ DAYS TOTAL SERVICES ______

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

8 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

3. Station involvement is for mating of spacecraft with upper stage (OTV or equivalent) using RMS or equivalent. Station could store spacecraft until ready for mating. Involvement ends with launch from LEO into escape trajectory. No station resources are required, however a spacecraft-to-ground data link is required for checkout. Two men required (4 hours each) for 1 day.

TOTAL EVA HRS 0

Code: GDCD 0110

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Saturn Probe

Reference Documents:

1. Solar System Exploration Committee Recommended Core Program, Nov 1982

Narrative:

This is a recommended mission in the Ref (1) program.

Crew requirements and station operations were derived. The importance of the space station to the mission was rated a "5" because the payload could be launched from the shuttle with existing upper stage vehicles. However the availability of a space station does permit bringing the spacecraft to LEO well in advance of escape launch, reducing reliance on the availability of a shuttle during the launch window.

PAYLOAD ELEMENT NAME
Comet T2 Rendezvous

CODE G D C D 0 1 2 1

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☒ Planned
- ☐ Candidate
- ☐ Opportunity

First flight, yr 1992
No. of flights 1
Duration of Flight, days 1

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 2

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

OBJECTIVE

Characterize the comet's nucleus, coma, and dust with Spacecraft on-board instrumentation.

DESCRIPTION

The opportunity to rendezvous with a comet, an encounter with zero relative velocity, represents one of the most exciting challenges ever to the unmanned space exploration program. A rendezvous with TEMPEL 2 should provide one of the most significant steps toward understanding solar system origin and evolution since the first examination of lunar material.

CODE G D C D 0 1 2 1

ORBIT CHARACTERISTICS

Apogee, km LEO ____ Perigee, km LEO ____ Tolerance + ____ - ____

Inclination, deg 28.5 ____ Tolerance + ____ - ____

Nodal Angle, deg ____ Ephemeris Accuracy, m ____

Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ____

Pointing accuracy, arc sec ____ Field of view, deg ____

Pointing Stability (Jitter) arc sec/sec ____

Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	____	____
Standby	____	____
Peak	____	____

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:

☒ None ☐ Realtime ☐ Offline ☐ Other ____

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____

☐ On-Board Data Processing Required

Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____

Film (Amount) ____ Voice (Hrs/Day) ____

Live TV (Hrs/Day) ____ Other ____

On-Board Storage (MBIT) ____

Data Dump Frequency (Per Orbit) ____

Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 0 1 2 1

THERMAL

☐ Active ☐ Passive

Temperature, deg C — operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w — operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed
L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 2200

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2

Skills (See Table B) — Task Assignment

SKILL	7	7				
LEVEL	3	2				
Hrs/Day	4	4				

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Station involvement with Spacecraft ends with launch from LEO into escape trajectory. A ground data link is required for prelaunch checkout. No communication required after launch. No servicing required.

GDCD CODE 0121 ELEMENT NAME COMET T2 RENDEZVOUS

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1992 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

8 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

3. Station involvement is for mating of spacecraft with upper stage (OTV or equivalent) using RMS or equivalent. Station could store spacecraft until ready for mating. Involvement ends with launch from LEO into escape trajectory. No station resources are required, however a spacecraft-to-ground data link is required for checkout. Two men required (4 hours each) for 1 day.

TOTAL EVA HRS 0

Code: GDCD 0121

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Comet Tempel 2 Rendezvous

Reference Documents:

1. MSFC Letter, D. Saxton to Boeing and GDC, "Planetary Mission Requirements for OTV," 7/30/79

2. S.A.I. Report No. SAI 1-120-340-T19, Sept 1982; Telecon, J. Niehoff, Oct 1982

3. Solar System Exploration Committee Recommended Core Program, Nov 1982

4. NASA Lunar and Planetary Mission Handbook, Volume IV, May 1979

Narrative:

A Comet Rendezvous is one of the missions recommended in the Ref (3) program. Tempel 2 was selected because of the existence of a good launch opportunity during the 1990s and the availability of a good mission analysis in Ref (2). Objectives and description are based on material in Ref (4). The mission is also included in Ref (1).

Crew requirements and station operations were derived. The importance of the space station to the mission was rated a "5" because the payload could be launched from the shuttle with existing upper stage vehicles. However the availability of a space station does permit bringing the spacecraft to LEO well in advance of escape launch, reducing reliance on the availability of a shuttle during the launch window.

PAYLOAD ELEMENT NAME
Main-Belt Asteroid Rendezvous

CODE G D C D 0 1 2 2

TYPE

- [x] Science & Applications (non-commercial)
- [ ] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A) 2

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- [ ] Operational
- [ ] Approved
- [x] Planned
- [ ] Candidate
- [ ] Opportunity

First flight, yr 1992
No. of flights 1
Duration of Flight, days 1

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

OBJECTIVE

To rendezvous with a Main Belt asteroid and conduct scientific investigations of it and its surrounding region.

DESCRIPTION

Main Belt asteroids are believed to have remained relatively unchanged since their formation in the primordial Solar System. Examination of these objects from near distances is expected to yield excellent information on composition, morphology, structure, and bulk properties. Such new data may indicate the mode(s) of asteroical accretion and also yield information on the composition of the solar nebula from which the planets condensed.

CODE
G D C D 0 1 2 2

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ____ - ____
Inclination, deg 28.5 Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☒ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 0 1 2 2

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 2700

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2

Task Assignment ______

Skills (See Table B)

SKILL	7	7				
LEVEL	3	2				
Hrs/Day	4	4				

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Station involvement with Spacecraft ends with launch from LEO into escape trajectory. A ground data link is required for prelaunch checkout. No communication required after launch. No servicing required.

GDCD CODE 0122 ELEMENT NAME MAIN-BELT ASTEROID RENDEZVOUS

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1992 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   8 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

3. Station involvement is for mating of spacecraft with upper stage (OTV or equivalent) using RMS or equivalent. Station could store spacecraft until ready for mating. Involvement ends with launch from LEO into escape trajectory. No station resources are required, however a spacecraft-to-ground data link is required for checkout. Two men required (4 hours each) for 1 day.

TOTAL EVA HRS 0

Code: GDCD 0122 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Main-Belt Asteroid Rendzvous

Reference Documents:

1. JPL Internal Memo, A.Y. Nakata, "Mariner Mark II Preliminary Mission Requirements Report,: Rev. 2, 10/1/82; GDC Visit, Oct 1982

2. Solar System Exploration Committee Recommended Core Program, Nov 1982

Narrative:

This is a recommended mission in the Ref (2) program. Objectives and description are based on material in Ref (1).

Crew requirements and station operations were derived. The importance of the space station to the mission was rated a "5" because the payload could be launched from the shuttle with existing upper stage vehicles. However the availability of a space station does permit bringing the spacecraft to LEO well in advance of escape launch, reducing reliance on the availability of a shuttle during the launch window.

PAYLOAD ELEMENT NAME
Comet HMP Sample Return

CODE G D C D 0 1 2 3

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☒ Planned
- ☐ Candidate
- ☐ Opportunity

First flight, yr 1994
No. of flights 1
Duration of Flight, days 2

OBJECTIVE

To obtain samples of volatile and nonvolatile constituents of the comet during a fast fly-through and return them to Earth for analysis.

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 2

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

DESCRIPTION

A comet sample is likely to be the most primitive sample of extraterrestrial material we can study in the foreseeable future. Comets exude an atmosphere of volatile compounds which indicate a low parent body temperature. Information regarding the primitive materials is presumably "frozen-in" in the constituents of comets and their relationship to one another. No other object in the solar system is likely to be a source of the type of information contained in the comets. HMP is one of several candidate comets suitable for the sample return mission.

CODE G D C D 0 1 2 3

ORBIT CHARACTERISTICS

Apogee, km LEO ____ Perigee, km LEO ____ Tolerance + ____ -
Inclination, deg 28.5 ____ Tolerance + ____ -
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	____	____
Standby	____	____
Peak	____	____

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 0 1 2 3

THERMAL
☐ Active ☐ Passive
Temperature, deg C operational min ______ max ______
non-operational min ______ max ______
Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS
Location: ☐ Internal ☒ External ☐ Remote
Equipment ID/Function ☐ Pressurized ☒ Unpressurized
L,m ______ W,m ______ H,m ______ Stowed
L,m ______ W,m ______ H,m ______ Deployed
Launch mass, kg 200
Consumables Types ______
Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS
Crew Size 2
Skills (See Table B) Task Assignment

SKILL	7	7				
LEVEL	3	2				
Hrs/Day	4	4				

EVA ☒ YES ☐ NO Reason Retrieve Sample Hrs A 4

SERVICING/MAINTENANCE
SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______
CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Station personnel involved both in mating of Spacecraft (1 day) and retrieval of sample return module upon return from comet in 1998 (1 day). Spacecraft ground data link required for prelaunch checkout.

GDCD CODE 0123 ELEMENT NAME COMET HMP SAMPLE RETURN

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1994 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

8 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) 1998 INT. HRS. 8 EVA HRS 4 EVA CREW 1

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

3. Station involvement is for mating of spacecraft with upper stage (OTV or equvivalent) using RMS or equivalent. Station could store spacecraft until ready for mating. Involvement ends with launch from LEO into escape trajectory. No station resources are required, however a spacecraft-to-ground data link is required for checkout. Two men required (4 hours each) for 1 day.
5. Inspection/packaging of sample for Earth return (one time)

TOTAL EVA HRS 4

Code: GDCD 0123

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Comet HMP Sample Return

Reference Documents:

1. Paper, Astronautics and Aeronautics Journal, Jesse W. Moore (NASA), "Effective Planetary Exploration at Low Cost," Oct 1982
2. JPL Internal Memo, A.Y. Nakata, "Mariner Mark II Preliminary Mission Requirements Report,: Rev. 2, 10/1/82; GDC Visit, Oct 1982
3. Solar System Exploration Committee Recommended Core Program, Nov 1982
4. NASA Lunar and Planetary Mission Handbook, Volume IV, May 1979

Narrative:

This is a recommended mission in the Ref (3) program. Objectives and description are based on material in Ref (2), Section 2.3 and Table 4.2-4, and Ref (4), Section CSR. The mission is also included in Ref (1).

Crew requirements and station operations were derived. The importance of the space station to the mission was rated a "5" because the payload could be launched from the shuttle with existing upper stage vehicles. However the availability of a space station does permit bringing the spacecraft to LEO well in advance of escape launch, reducing reliance on the availability of a shuttle during the launch window.

PAYLOAD ELEMENT NAME
Near Earth Asteroid Rendezvous

CODE G D C D 0 1 2 4

TYPE
- [X] Science & Applications (non-commercial)
- [ ] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A) 2

CONTACT

Name	W. Hardy/J. Peterson MZ 21-9530
Address	General Dynamics Convair Division P.O. Box 85357 San Diego, CA 92138
Telephone	(619) 277-8900, Ext. 3778/2130

STATUS
- [ ] Operational
- [ ] Approved
- [ ] Planned
- [X] Candidate
- [ ] Opportunity

First flight, yr 1997
No. of flights 1
Duration of Flight days 1

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

OBJECTIVE

To conduct remote sensing of a near-Earth asteroid while in its neighborhood over a period of several months to determine its physical, morphological, and mineralogical characteristics.

DESCRIPTION The asteroids are a population of bodies, 1000 km diameter and smaller, that orbit the Sun in modestly inclined and eccentric orbits between the orbits of Earth and Jupiter, concentrated between 2 and 4 AU. Asteroids may be remnants of a planet that failed to accrete in the belt; unlike comets, they probably orbit at roughly the distance from the Sun at which they accreted.

As the only remaining population of minimally altered remnants from the accretional phase of solar system history still in roughly their original orbits, the asteroids offer unique clues to the first half-billion years of planetary evolution.

CODE G D C D 0 1 2 4

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ____ - ____
Inclination, deg 28.5 ____ Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s 4120

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☒ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req : Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 0 1 2 4

THERMAL

☐ Active ☐ Passive

Temperature, deg C — operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w — operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 1170

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2

Task Assignment ______

Skills (See Table b)

SKILL	7	7				
LEVEL	3	2				
Hrs/Day	4	4				

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Station involvement with Spacecraft ends with launch from LEO into escape trajectory. A ground data link is required for prelaunch checkout. No communication required after launch. No servicing required.

GDCD CODE 0124 ELEMENT NAME NEAR EARTH ASTEROID RENDEZVOUS

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1997 INT. HRS ____ VA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

8 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

3. Station involvement is for mating of spacecraft with upper stage (OTV or equivalent) using RMS or equivalent. Station could store spacecraft until ready for mating. Involvement ends with launch from LEO into escape trajectory. No station resources are required, however a spacecraft-to-ground data link is required for checkout. Two men required (4 hours each) for 1 day.

TOTAL EVA HRS 0

Code: GDCD 0124

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Near Earth Asteroid Rendezvous

Reference Documents:

1. Paper, Astronautics and Aeronautics Journal, Jesse W. Moore (NASA), "Effective Planetary Exploration at Low Cost," Oct 1982

2. S.A.I. Report No. SAI 1-120-340-T19, Sept 1982; Telecon, J. Niehoff, Oct 1982

3. MSFC, Solar System Exploration Scenario, Sept 1982; GDC Visit, Oct 1982

4. JPL Internal Memo, A.Y. Nakata, "Mariner Mark II Preliminary Mission Requirements Report,: Rev. 2, 10/1/82; GDC Visit, Oct 1982

5. Solar System Exploration Committee Recommended Core Program, Nov 1982

6. NASA Lunar and Planetary Mission Handbook, Volume IV, May 1979

Narrative:

This is a recommended mission in the Ref (5) program. Objectives and description were obtained from Ref (6), Section AMR. Ref 1, 2, 3, and 4 include this mission.

Crew requirements and station operations were derived. The importance of the space station to the mission was rated a "5" because the payload could be launched from the shuttle with existing upper stage vehicles. However the availability of a space station does permit bringing the spacecraft to LEO well in advance of escape launch, reducing reliance on the availability of a shuttle during the launch window.

PAYLOAD ELEMENT NAME
Det & Mon of Episodic Events

CODE G D C D 0 1 5 1

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1998
No. of flights 1
Duration of Flight, days 1825

OBJECTIVE

Monitoring of areas with high susceptibility to crustal hazards (earthquakes, volcanic eruptions, landslides), monitoring meteorological events (tornado prone fronts or large storm buildups), and oceanological events (tsunamis and iceberg concentrations).

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 2

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 9

DESCRIPTION

For the detection and monitoring of episodic events the payload will consist of the following instruments for Earth viewing: Multiband Imaging Spectrometer, Multiband Thermal IR Imager, Synthetic Aperture Radar, Passive Microwave Radiometer, Scanning Laser Altimeter, Laser Fluorometer. A boresighted optical system with many sensors slaved to it, and on-board capability of changing spectral and spatial resolution of the instruments is included. Support elements include real time on-board processing and display simultaneously with down link, direct communication link between on-board crew and ground support elements. Capable of on-orbit instrument selection.

CODE G D C D 0 1 5 1

ORB. CHARACTERISTICS
Apo e, km 450 Perigee, km 450 Tolerance + 50 - 50
Inclination, deg 90 Tolerance + 10 - 10
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION
View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec 6 Field of view, deg ±30 Nadir
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) water vapor/scattered light

ER
☐ AC ☒ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V 28 Frequency, Hz ______

DATA/COMMUNICATIONS
Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☒ Uplink Req.: Command Rate (KBS) 20 Frequency (MHZ) ______
☒ On-Board Data Processing Required
Description For Display

Data Types: ☒ Analog ☒ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) 2,000,000
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 300,000 Downlink Frequency (MHZ) ______

CODE G D C D 0 1 5 1 Page 3 of 3

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min 10 max 35
non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 10 W,m 4 H,m 3 Stowed

L,m 16 W,m 10 H,m 3 Deployed

Launch mass, kg 3500

Consumables Types Cryogens

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 2 Task Assignment Monitor Instruments/Data

Skills (See Table B)

SKILL	4	4				
LEVEL	3	2				
Hrs/Day	0.5	0.5				

EVA ☒ YES ☐ NO Reason Sensor Changeout Hrs/EVA 16

SERVICING/MAINTENANCE

SERVICE: Interval, days 365 Consumables, kg ____

Returnables, kg ____ Man Hours 4

CONFIGURATION CHANGES: Interval, day 700 Man/Hrs Req. 8

Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Ground track repeat cycle: 3 days with ability to lock into specific orbits. Real time communication between the crew, scientist, and possibly civil authorities.

GDCD CODE 0151 ELEMENT NAME DETECTION AND MONITOR OF EPISODIC EVENTS

ACCOMODATION: [X] ATTACHED [ ] FREE FLYER [ ] OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1998 INT. HRS ____ EVA HRS ____ EVA CREW ____

[ ] NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 365 DAYS TOTAL SERVICES 4

[ ] TMS/OTV REQUIRED ____ STATION HRS PER SERVICE 2

[ ] NOT APPLICABLE ____ EVA HRS PER SERVICE 2

EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

1.0 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

[ ] NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 700 DAYS TOTAL RECONFIGS. 2

[ ] TMS/OTV REQUIRED STATION HRS PER RECONFIG. 4

[ ] NOT APPLICABLE EVA HRS PER RECONFIG. 4

EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

[X] NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

2. Assume resupply cryogenics
3. Assume ground provides alert to on-board crew, and/or on-board software provides cues to events
4. Sensor reconfiguration
5. Payload operations continue after year 2000

TOTAL EVA HRS 16

Code: GDCD 0151

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Detection Monitoring of Episodic Events

Reference Documents:

1. Space Station NAAO Study, Orientation Meeting Handout, NASA Headquarters, 14-15 September 1982

2. Space Platform Payload Data, Science and Application Space Plaztform Payload Accommodations Study, SP82-MSFC-2583, March 1982

3. Strawman Payload Data for Science and Applications Space Platforms, Final Report, SP80-MSFC-2403, January 1980

4. Science and Applications Requirements for Space Station, Draft, Provided 17 November 1982 at Interim Review at NASA Headquarters

Narrative:

The principal feature of this payload is the capability of providing data in near real time as related to hazards attributable to earth crustal events.

The principal data were obtained from Ref (1), p. 79 and verified by Ref 4, p. 68.

The flight date, duration, and crew requirements were estimated by GDC.

The power and dimensions were based on similar equipment data found in Ref 2 and 3.

The payload is attached to the space station.

PAYLOAD ELEMENT NAME
Geoscience - Crustal Dyn Studies

CODE G D C D 0 1 5 2

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900 Ext. 3778/2130

STATUS

☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 1100

OBJECTIVE Obtain information on the accumulation of strain in seismically active regions that is needed for fundamental theoretical and computational studies for both earthquakes and other processes that determine the Earth's surface, which are necessary to provide a framework for interpreting geodetic measurements and for modeling the underlying physical processes.

TYPE

☒ Science & Applications (non-commercial)
☐ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 2

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

DESCRIPTION

Instrument system on space station consists of NdYAG laser using a 0.2 nanosecond pulse length. The sensor is 1.5 × 1.5 × 2.5 meters and contains an agile pointing mirror. The measurement objective of system is a relative position uncertainty in locations of ground based retroflectors of 1 cm precision or better for separation of reflectors on the order of several thousand Km.

CODE G D C D 0 1 5 2

ORBIT CHARACTERISTICS

Apogee, km 500 Perigee, km 500 Tolerance + 100 - 200
Inclination, deg 50 Tolerance + 4C - 0
Nodal Angle, deg ______ Ephemeris Accuracy, m ±50 Real Time
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) Ground targets corner cube array retroreflectors
Pointing accuracy, arc sec 60 Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	500	6
Standby		
Peak		

☐ Continuous

Voltage, V 28 Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☒ None ☐ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) 100
Data Dump Frequency (Per Orbit) 0.1
Recording Rate (KBPS) 10 Downlink Frequency (MHZ) ______

CODE G D C D 0 1 5 2

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min 10 max 35

non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____

non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 2.5 W,m 1.5 H,m 1.5 Stowed

L,m 2.5 W,m 1.5 H,m 1.5 Deployed

Launch mass, kg 185

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 1

Task Assignment Select Targets/Observe Data

Skills (See Table B)

SKILL	5					
LEVEL	2					
Hrs/Day	0.2					

EVA ☒ YES ☐ NO Reason Laser Changeout Hrs/EVA 2

SERVICING/MAINTENANCE

SERVICE: Interval, days 550 Consumables, kg 30

Returnables, kg ____ Man Hours 4

CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____

Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Preferred circular orbit.

GDCD CODE 0152 ELEMENT NAME GEOSCIENCE-CRUSTAL DYNAMICS STUDIES

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER * ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1990 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 550 DAYS TOTAL SERVICES 1

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE 2

   ☐ NOT APPLICABLE ____ EVA HRS PER SERVICE 2

   EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.2 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) 1993 INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

*Free flyer accommodation is an alternate mode, and if used will require re-evaluation of all requirements.

2. Laser changeout
3. Monitor
5. Station Ops

TOTAL EVA HRS 2

Code: GDCD 0152

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Geoscience-Crustal Dynamics Studies

Reference Documents:

1. Science and Applications Requirements for Space Station, Draft, Provided 17 November 1982 at Interim Review at NASA Headquarters

Narrative:

The payload is to provide measurements of earth crustal deformation which can provide information on stresses within the earth, the interior rheology, and subsurface structure.

Crustal deformation can be interpreted in terms of tectonic plate motion, strain accumulation and release, and other horizontal and vertical motions. This study will provide data needed for fundamental, theoretical, and computational studies of both earthquakes and other processes that deform the earth's surface, which are necessary to provide a framework for interpreting geodetic measurements and for modeling the underlying physical processes.

The Spaceborne Laser Ranging System consists of a pulsed laser distance measurement system that sequentially measures the distance to a number of retroreflector arrays on the ground. From orbit, the laser measures the range to the corner reflectors on the earth's surface as it passes overhead. The measurements can be stored on the station and, subsequently, relayed to a ground terminal. The measurement objective of the system is a relative position uncertainty in the locations of the reflectors of 1 cm precision or better for separations of reflectors on the order of several thousand kilometers.

The technical requirements were obtained from Ref (1), paragraph 3.1.3.2.2.

The schedule and crew requirements were estimated by GDC.

PAYLOAD ELEMENT NAME
Earth SCI Res-Geophysical Inv

CODE G D C D 0 1 6 1

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1998
No. of flights 1
Duration of Flight, days 800

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 2

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 6

OBJECTIVE

To map time-variant changes in the Earth's magnetic field and to map crustal magnetic anomalies.

DESCRIPTION

Using vector and scalar magnetometers and magnet field gradiometer the time-variant changes in the Earth's magnetic field will be measured at low Earth orbit over the entire globe at intervals of six months. Tethered satellites and 100-meter booms will be used to deploy sensors from the space station.

CODE G D C D 0 1 6 1

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 5 100 - 125
Inclination, deg 90 Tolerance + 5 - 5
Nodal Angle, deg ______ Ephemeris Accuracy, m ±10
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec 1800 Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	130	24
Standby		
Peak	1200	

☐ Continuous

Voltage, V 28 Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☒ Digital ☒ Hrs/Day 24
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) 10,000
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 30 Downlink Frequency (MHZ) ______

CODE G D C D 0 1 6 1

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min 10 max 35
non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 3 W,m 3 H,m 2 Stowed
L,m 100 W,m 2 H,m 2 Deployed

Launch mass, kg 400

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 1

Task Assignment Monitor Instruments/Data

Skills (See Table B)

SKILL	5					
LEVEL	2					
Hrs/Day	0.5					

EVA ☐ YES ☒ NO Reason ____ Hrs/EVA ____

SERVICING/MAINTENANCE

SERVICE: Interval, days ____ Consumables, kg ____
Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Deployment of tethered satellite and 100-meter nonmagnetic boom will be required. It is required to determine the orbit epherimis to plus/minus 10 meters.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0161 ELEMENT NAME EARTH SCIENCE RESEARCH

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1995 INT. HRS 8 EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.5 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) 1997 INT. HRS. 8 EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Station ops plus deploy boom
3. Monitor, deploy/retrieve satellite
5. Station ops plus retract boom

TOTAL EVA HRS 0

Code: GDCD 0161

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Earth Science Research-Geophysical Investigation

Reference Documents:

1. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982

Narrative:

It is believed that the earth's crustal magnetic anomalies can be inferred from gradients measured at orbital altitudes. The payload will use magnetometer bearing tethered satellite(s).

The payload's principal requirements were obtained from Ref 1.

The crew, orbit altitude, and schedule were estimated by GDC.

Data rate, power, and physical characteristics were estimated based on similarity to equipment listed in Ref 1.

PAYLOAD ELEMENT NAME
Renewable Resources - E/SCI Res

CODE G D C D 0 1 7 1

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1996
No. of flights 1
Duration of Flight, days 1825

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 2

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

OBJECTIVE

To acquire spectrum wide multiband data of global land areas for renewable Earth, resources research in biomass, hydrology, land use and geosciences. The specific objective is to perform vegitation sciences research, vegitation resources inventory and monitoring, land cover dynamic research, hydrauliccycle research, and water resources inventory and monitoring.

DESCRIPTION Principal features of the sensors are multispectral, high spatial resolution and Earth viewing. The instruments are: for vegitation science research, multispectral linear array (MLA) sensor; for vegitation resources inventory and monitoring, imaging radiometer and radar altimeter; for land cover research - imaging radiometer (as above) and synchotic aperture radar; for hydrological research - imaging radiometer (as above), active radar and passive microwave radiometer (radar and microwave radiometer each require 15-m dia antenna); for water resources inventory and monitoring - multichannel passive microwave radiometer (for snow-4-m dia antenna) and multispectral sensor for maping polution/sedimentation in water and snow.

CODE
G D C D 0 1 7 1

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 100 - 100
Inclination, deg 90 Tolerance + 0 - 33
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec 3600 Field of view, deg ±45 Nadir
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	5000	
Standby	200	
Peak	7000	

☐ Continuous

Voltage, V 28 Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other ______
☒ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) 10 Frequency (MHZ) ______
☒ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☒ Digital ☒ Hrs/Day 24
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) 10,000,000
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 100,000 Downlink Frequency (MHZ) ______

CODE G D C D 0 1 7 1

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min 10 max 35
non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ____ W,m ____ H,m ____ Stowed

L,m 40 W,m 30 H,m 3 Deployed

Launch mass, kg 2000

Consumables Types Cryogen

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 2 Task Assignment Monitor/Select Inst/Data

Skills (See Table B)

SKILL	4	5				
LEVEL	3	2				
Hrs/Day	0.5	0.5				

EVA ☒ YES ☐ NO Reason Resupply Cryo/Reconfig Hrs/EVA 34

SERVICING/MAINTENANCE

SERVICE: Interval, days 180 Consumables, kg 200
Returnables, kg ____ Man Hours 4

CONFIGURATION CHANGES: Interval, day 365 Man/Hrs Req. 8
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

For shortwave and thermal IR instruments their active cooling systems require cooling and replacement by the crew. For water resources pointing accuracy of 0.1 degree and pointing stability is 5 arc-sec. Revisit frequency: 2 to 5 days repeat global coverage. Accurate epheneris data (in real-time data stream). This mission has several parts (see description) and all parts may not be included at one time.

GOCO CODE 0171 ELEMENT NAME RENEWABLE RESOURCES-EARTH SCIENCES RESOURCES

ACCOMODATION: [X] ATTACHED [ ] FREE FLYER* [ ] OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1996 INT. HRS ______ EVA HRS ______ EVA CREW ______

[ ] NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 180 DAYS TOTAL SERVICES 9

[ ] TMS/OTV REQUIRED ______ STATION HRS PER SERVICE 2

[ ] NOT APPLICABLE ______ EVA HRS PER SERVICE 2

EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

1.0 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

[ ] NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 365 DAYS TOTAL RECONFIGS. 4

[ ] TMS/OTV REQUIRED STATION HRS PER RECONFIG. 4

[ ] NOT APPLICABLE EVA HRS PER RECONFIG. 4

EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

[X] NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

* Free flyer accommodation is an alternate mode, and if used will require re-evaluation of all requirements

1. Station ops
2. Cryo service
3. 2 men @ 0.5 hours each (average)
4. Sensor changeout
5. Continued past year 2000

TOTAL EVA HRS 34

Code: GDCD 0171

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Renewable Resources-Earth Science Research

Reference Documents:

1. Space Station NAAO Study, Orientation Meeting Handout NASA Headquarters, 14-15 September 1982

2. Science and Applications Requirements for Space Station, Draft, Provided 17 November 1982 at Interim Review at NASA Headquarters

Narrative:

The payload is intended to increase through spectral band measurements, understanding of earth's renewal resources for solution of food and fiber resources problems.

The payload requirements were obtained initially from Ref 1, p. 30 and refined based on Ref 2, (para. 3.1.3.1).

The schedule and crew requirements were estimated by GDC.

Mass Estimates: Renewable Resources - Earth Science Research

	kg	Power
1. MLA -	300	500
2. Imaging Radiometer 3. Radar Altimeter	100	100
4. SAR -	300	500
5. Active Radar (15m antenna)	550	500
6. Passive μ-wave Radiometer (15m antenna)	300	
7. Multi-channel Passive μ-wave Radiometer (4m antenna)	200	500
8. Multi-spectral sensor	250	
Total:	2,000	

PAYLOAD ELEMENT NAME
Operational Land Systems

CODE G D C D 0 1 7 2

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 3650

OBJECTIVE

To acquire multispectral coverage of global land areas for operational Earth resources exploration and monitoring using remote sensing.

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 2

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 9

DESCRIPTION

Principal features of the sensors are multispectral, high spatial resolution stable platform mounted for precision pointing and near continuous nadir viewing using large antennas up to 20 meters. Typical instruments are imaging radiometer, radar altimeter, synthetic aperture radar, microwave and IR radiometers, and multiband thermal (IR imager). The orbit selection will be such that the ground track will be repeated every 7 to 10 days. This mission will probably be a free flyer and serviced on orbit.

CODE G D C D 0 1 7 2

ORBIT CHARACTERISTICS

Apogee, km 500 Perigee, km 500 Tolerance + 500 - 0
Inclination, deg 90 Tolerance + 10 - 10
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec 360 Field of view, deg ±45 nadir
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	8000	
Standby	200	
Peak	10,000	

☐ Continuous

Voltage, V 28 Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other ______
☐ Encryption/Decryption Required
☒ Uplink Req.: Command Rate (KBS) 10 Frequency (MHZ) ______
☒ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) 10,000,000
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 300,000 (compressed) Downlink Frequency (MHZ) ______

CODE G D C D 0 1 7 2

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min 10 max 35
non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 4 W,m 4 H,m 3 Stowed
L,m 30 W,m 30 H,m 3 Deployed

Launch mass, kg 2000

Consumables Types Cryogen

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size ____ Task Assignment ____

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☒ YES ☐ NO Reason Reconfig/Service Hrs/EVA 24

SERVICING/MAINTENANCE

SERVICE: Interval, days 730 Consumables, kg 200
Returnables, kg ____ Man Hours 4

CONFIGURATION CHANGES: Interval, day 730 Man/Hrs Req. 8
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Syn synchronous orbit, AM equatorial crossing. Revisit: 7 to 10 day ground track repeat cycle. Stable platforms. Light and EMR contamination free. Accurate ephemeris data (in real time data stream).

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0172 ELEMENT NAME OPERATIONAL LAND SYSTEMS

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1990 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 730 DAYS TOTAL SERVICES 4

   ☒ TMS/OTV ~~REQUIRED~~ ALTERNATE — STATION HRS PER SERVICE 2

   ☐ NOT APPLICABLE — EVA HRS PER SERVICE 2

   EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ____ HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL 730 DAYS TOTAL RECONFIGS. 4

   ☐ TMS/OTV REQUIRED — STATION HRS PER RECONFIG. 4

   ☐ NOT APPLICABLE — EVA HRS PER RECONFIG. 4

   EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

   DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

This payload element has orbit transfer propulsion

2. Cryo Service
4. Change sensors
5. Free flyer continues past year 2000

TOTAL EVA HRS 24

Code: GDCD 0172 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Operational Land Systems

Reference Documents:

1. Space Station NAAO Study, Orientation Meeting Handout `SA Headquarters, 14-15 September 1982

2. NASA TM-82482, MSFC, April 1982

Narrative:

A free-flyer accommodation was selected primarily due to orbit inclination required in the early time frame. The payload is assumed to provide LANDSAT-type data.

Requirements were derived from Ref 1. The spacecraft includes orbit transfer propulsion.

Service and maintenance requirements and schedule were estimated. The configuration change is assumed to be accomplished by man Ref 2.

Landsat D mass is 1724 kg; Estimate for this advanced version is 2000 kg.

PAYLOAD ELEMENT NAME
Shuttle Active Microwave Exp

CODE
G D C D 0 1 7 3

CONTACT

Name: W. Hardy/J. Peterson MZ 21-9530

Address:
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1992
No. of flights 1
Duration of Flight, days 730

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 2

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 6

OBJECTIVE

Continue development of NASA imaging radar sensors for operational use in spaceborne imaging radars probe for all weather imaging of Earth's land and ocean surfaces.

DESCRIPTION

The Shuttle active microwave experiment (SAMEX-C) for space station will use C-band radar imaging equipment having a synthetic aperture radar with a large antenna using dual polarization, and incidence angles between 15 and 65 degrees. An advanced digital SAR processor (JPL) is a potential having a computational capability of 2.5 billion operations per second.

CODE G D C D 0 1 7 3

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 100 - 125
Inclination, deg 90 Tolerance + 0 - 61.5
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec 3600 Field of view, deg 20 to 75 of nadir
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	5000	12
Standby	300	
Peak	7500	

☐ Continuous

Voltage, V 28 Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☒ On-Board Data Processing Required
Description 160 MBPS for 16-bit complex words (10 MHz)

Data Types: ☒ Analog ☒ Digital ☐ Hrs/Day ______
Film (Amount TBD Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) TBD
Data Dump Frequency (Per Orbit) 5
Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

CODE GDCD0173

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min 10 max 35

non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____

non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 6 W,m 2 H,m 2 Stowed

L,m 15 W,m 3 H,m 2 Deployed

Launch mass, kg 2000

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 1 Task Assignment Checkout/Operate Equipment

Skills (See Table B)

SKILL	4					
LEVEL	3					
Hrs/Day	2					

EVA ☒ YES ☐ NO Reason Reconfiguration Hrs/EVA 2

SERVICING/MAINTENANCE

SERVICE: Interval, days ____ Consumables, kg ____

Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day 365 Man/Hrs Req. 4

Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

GOCD CODE 0173 ELEMENT NAME SAMEX-C

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1992 INT. HRS ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ______ DAYS TOTAL SERVICES ______

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.2 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 365 DAYS TOTAL RECONFIGS. 1

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 2

☐ NOT APPLICABLE EVA HRS PER RECONFIG. 2

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) 1994 INT. HRS. ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Station ops
3. Equip operations (average)
4. EVA and station support of sensor reconfiguration
5. Station ops

TOTAL EVA HRS 2

Code: GDCD 0173

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Shuttie Active Microwave Experiment (SAMEX-C)

Reference Documents:

1. Space Station NAAO Study, Orientation Meeting Handout NASA Headquarters, 14-15 September 1982
2. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982
3. Strawman Payload Data for Science and Applications Space Platforms, Final Report, SP80-MSFC-2403, January 1980
4. Spaceborne Imaging Radar Probe "In-Depth," IEEE Spectrum, November 1982, Elachi & Granger of JPL.

Narrative:

This payload is another step to NASA development of imaging radar. This schedule is shown in Ref 1.

The data were derived from Ref (4) except: a) The physical size and mass which was estimated by GDC based on similar equipment found in Ref 2 and 3, and b) orbit which was given by GDC as preferred for global coverage.

SAMEX-C Mass Estimate

SAR - MSFC/JPL

Radar	800 kg	6000 W.
Integration HW	1,076 kg	486 W.
	1,876 kg	6486 W.
+ growth:	124 kg	
Total:	2,000 kg	

PAYLOAD ELEMENT NAME
Earth Obs Instr Dev - Microwave

CODE G D C D 0 1 7 4

TYPE

- [x] Science & Applications (non-commercial)
- [ ] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A) 2

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- [ ] Operational
- [ ] Approved
- [ ] Planned
- [x] Candidate
- [ ] Opportunity

First flight, yr 1991
No. of flights 1
Duration of Flight, days 730

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 9

OBJECTIVE

Demonstrate smart sensor technology for passive microwave remote measurements with real time target adaptable sensor mode optimization such as resolution cell size are measurement accuracy.

DESCRIPTION

Passive microwave remote sensing technology payload consisting imaging radiometer for development and evaluation using multibeam and multifrequency techniques. Simultaneous measurement of geographical parameters to be performed are: sea surface temperature, ocean surface wind speed, rain rate, sea ice classification data, atmospheric data, etc.

CODE G D C D 0 1 7 4

ORBIT CHARACTERISTICS

Apogee, km 1000 Perigee, km 1000 Tolerance + 600 - 600
Inclination, deg 90 Tolerance + 0 - 61.5
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec 360 Field of view, deg ±45 nadir
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	200	
Standby		
Peak		

☐ Continuous

Voltage, V 28 Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 1000 Downlink Frequency (MHZ) ______

CODE G D C D 0 1 7 4

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min 10 max 35
non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 1.5 W,m 1 H,m 1 Stowed
L,m 1.5 W,m 1 H,m 1 Deployed

Launch mass, kg 200

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 1 Task Assignment Deploy/Checkout/Monitor

Skills (See Table B)

SKILL	4					
LEVEL	3					
Hrs/Day	0.25					

EVA ☐ YES ☒ NO Reason ____ Hrs/EVA ____

SERVICING/MAINTENANCE

SERVICE: Interval, days ____ Consumables, kg ____
Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day 365 Man/Hrs Req. 4
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Space station preferred to use main-in-the -loop necessary to develop smart sensor technology in the optimum way and to demonstrate operational feasibility. (This payload could benefit commercial payload GDCD 1000.)

GOCD CODE 0174 ELEMENT NAME EARTH OBS INST DEVELOPMENT

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1991 INT. HRS ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ______ DAYS TOTAL SERVICES ______

   ☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

   ☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

   EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.25 HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL 365 DAYS TOTAL RECONFIGS. 1

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 4

   ☐ NOT APPLICABLE EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) 1993 INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Station ops
3. Deployment of Antenna, c/o, monitor
4. Reconfiguration for internal equipment only.
5. Station ops

TOTAL EVA HRS 0

Code: GDCD 0174

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Earth Observations Instrument Development (Microwave Technology)

Reference Documents:

1. Space Station NAAO Study, Orientation Meeting Handout NASA Headquarters, 14-15 September 1982

Narrative:

The payload is to develop passive microwave sensors for imaging radiometry related to oceanic surface phenomenon. A technology advancement is postulated.

The payload is based on data contained in Ref 1, attachment A, Technology, page 50.

The crew requirements and schedule are estimates of GDC.

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title: Earch Observation Instrument Langley Contact: R.F. Harrington

Experiment Title: Microwave Remote Sensing Technology-Passive Systems

Mission Objectives: Demonstration of smart sensor technology for passive microwave remote measurements with real time target adaptable sensor mode optimization such as resolution cell size and measurement accuracy.

Mission Description: A multiple frequency, multiple beam imaging microwave radiometer system would be developed and evaluated in space to measure several geophysical parameters simultaneous. These parameters are soil moisture, sea surface temperature, ocean surface wind speed, rain rate, sea ice classification data, atmospheric data, etc.

Benefit: This mission is needed to develop and demonstrate the technology for future operational earth observational satellites for measurement of many important geophysical parameters using passive techniques.

Justification: The feasibility of geophysical parameter measurements from passive microwave instruments has been demonstrated using satellite radiometers such as ESMR and SMMR. However, additional microwave instrument and algorithm development work is required to bring these measurements from a feasibility demonstration to an optimum operational basis.

Mission Requirements and Capability: Oribt: Altitude 500 to 1500 km

S/C Interface: Weight 200 kgm
Volume 1.5 m^3
Power 200 watts

Space Station vs. Free Flyer: Space station preferred to take advantage of man-in-the-loop modes necessary to develop smart sensor technology in the most optimum way.

PAYLOAD ELEMENT NAME
Earth Obs Instr Dev - Visible/RF

CODE G D C D 0 1 7 5

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 1994
No. of flights 1
Duration of Flight, days 730

TYPE
☒ Science & Applications (non-commercial)
☐ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 2

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 9

OBJECTIVE

To develop instrumentation, which senses various earthbound phenomena, with a wide variety of attributes, i.e, broad RF region and extra visible regions.

DESCRIPTION

Sense Earth-based phenomena outside the current restrictive bands in electromagnetic spectrum (e.g., the visible and relatively narrow RF band). Perform developmental testing and demonstrate operation potential.

CODE G D C D 0 1 7 5

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 600 - 125
Inclination, deg 90 Tolerance + 0 - 61.5
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required,m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ____
Pointing accuracy,arc sec 1800 Field of view, deg ±45 nadir
Pointing Stability (Jitter)arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	500	
Standby	100	
Peak	700	

☐ Continuous

Voltage,V 28 Frequency,Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 1000 Downlink Frequency (MHZ) ____

CODE G D C D 0 1 7 5

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min 10 max 35
non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 4 W,m 3 H,m 2 Stowed
L,m 8 W,m 4 H,m 2 Deployed

Launch mass, kg 1000

Consumables Types Cryogenics

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 1 Task Assignment Observe Equipment

Skills (See Table B)

SKILL	5					
LEVEL	3					
Hrs/Day	0.25					

EVA ☒ YES ☐ NO Reason Cryogens/Reconfig Hrs/EVA 4

SERVICING/MAINTENANCE

SERVICE: Interval, days 365 Consumables, kg ____
Returnables, kg ____ Man Hours 4

CONFIGURATION CHANGES: Interval, day 365 Man/Hrs Req. 4
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Man intervention in the development process. (This payload could benefit commercial payload GDCD 1000.)

GDCD CODE 0175 ELEMENT NAME EARTH OBS INSTRUMENT DEVELOPMENT (EXTRA VISIBLE & RF)

ACCOMODATION: [X] ATTACHED [ ] FREE FLYER [ ] OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1994 INT. HRS ______ EVA HRS ______ EVA CREW ______

[ ] NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 365 DAYS TOTAL SERVICES 1

[ ] TMS/OTV REQUIRED ______ STATION HRS PER SERVICE 2

[ ] NOT APPLICABLE ______ EVA HRS PER SERVICE 2

EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.25 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

[ ] NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 365 DAYS TOTAL RECONFIGS. 1

[ ] TMS/OTV REQUIRED STATION HRS PER RECONFIG. 2

[ ] NOT APPLICABLE EVA HRS PER RECONFIG. 2

EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

DATE(S) 1996 INT. HRS. ______ EVA HRS ______ EVA CREW ______

[ ] NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Station ops
2. Resupply cryogenics
3. Routine record and monitoring
4. Sensor reconfiguration
5. Station ops

TOTAL EVA HRS 4

Code: GDCD 0175

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Earth Observations Instrument Development (Extra Visible and Broad RF)

Reference Documents:

1. Space Station NAAO Study, Orientation Meeting Handout NASA Headquarters, 14-15 September 1982

Narrative:

This payload (outlined in Ref 1, Attachment A, p. 52) is essentially the same in requirements as GDCD 0174 except this payload concerns broad-band RF sensors and extra-visible region sensors.

PAYLOAD ELEMENT NAME
EO Sensor/Technique/Auto Sys Dev

CODE GDCD0176

CONTACT
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P.O. Box 85357
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Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1992
No. of flights 1
Duration of Flight, days 1460

TYPE
- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 2

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 10

OBJECTIVE

1. To develop Earth observing instrumentation and observing parameters for use in operational platforms.
2. To use a manual EO to locate and study remote sensing research with goal of defining analysis techniques.
3. To develop Earth observing techniques for rapidly communicating information to users in near real time.

DESCRIPTION A manned Earth Observatory will experiment with a variety of prototype Earth observing instrumentation. Studies of candidate spectral and spatial resolution of optimum Sun elevations and viewing angles and of various polarizations versus particular ground features are examples of technology that could be improved for use on later operational remote sensing satellites. Man will play a role in orienting instruments to observe and record phenomena that are transitory in either time or location. By using real-time displays he will select the best instrumentation to record what he was observing. Man will selectively transmit appropriate data to the ground for consultation with ground based experts. Man will develop techniques for detecting and monitoring episodic events, e.g., volcanoes, earthquakes, tidalwaves, and severe storms.

CODE G D C D 0 1 7 6

ORBIT CHARACTERISTICS

Apogee, km 500 Perigee, km 500 Tolerance + 425 - 225
Inclination, deg 90 Tolerance + 0 - 61.5
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec 3600 Field of view, deg ±45 nadir
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	6000	12
Standby		
Peak		

☐ Continuous

Voltage, V 28 Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other ______
☐ Encryption/Decryption Required
☒ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☒ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) 500,000
Data Dump Frequency (Per Orbit) 1.0
Recording Rate (KBPS) 80,000 Downlink Frequency (MHZ) ______

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CODE GDCD0176

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min 10 max 35

non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____

non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☒ Internal ☒ External ☐ Remote

Equipment ID/Function ☒ Pressurized ☒ Unpressurized

L,m ____ W,m ____ H,m ____ Stowed

L,m ____ W,m ____ H,m ____ Deployed

Launch mass, kg ____

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 2 Task Assignment Data Interpretation/Instr & Site Sel.

Skills (See Table B)

SKILL	4	5				
LEVEL	3	2				
Hrs/Day	0.5	0.5				

EVA ☒ YES ☐ NO Reason Cryogens/Reconfig Hrs/EVA 18

SERVICING/MAINTENANCE

SERVICE: Interval, days 180 Consumables, kg 200

Returnables, kg ____ Man Hours 4

CONFIGURATION CHANGES: Interval, day 730 Man/Hrs Req. 8

Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Earth viewing, aided by gimballed zoom optical system required. Pointable sensors with image motion compensation. This R&D laboratory is a combination of three basic missions as indicated under objectives. It will maximize mans capability to enhance sensor and scientific research and observation technique development.

GDCD CODE 0176 ELEMENT NAME EO SENSOR/TECHNIQUE/AUTO SYSTEM DEVELOPMENT

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1992 INT. HRS ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 180 DAYS TOTAL SERVICES 7

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE 2

☐ NOT APPLICABLE ______ EVA HRS PER SERVICE 2

EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

1.0 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 730 DAYS TOTAL RECONFIGS. 1

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 4

☐ NOT APPLICABLE EVA HRS PER RECONFIG. 4

EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

DATE(S) 1996 INT. HRS. ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Station OPS
2. Resupply Cryogenics
3. 2 crew men @ 0.5 hours each
4. Interchange arrays, filters and instruments
5. Station OPS

TOTAL EVA HRS 18

Code: GDCD 0176

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Earth Observations Sensor/Technique/Anslysis Automated System Development

Reference Documents:

1. Space Station NAAO Study, Orientation Meeting Handout NASA Headquarters, 14-15 September 1982

Narrative:

This payload was initially considered to be three distinct payloads; one to develop instruments, one to develop observing techniques, and a third to use manned earth observations to study remote sensing research with a goal of defining/refining analytical techniques. They are presented separately in Ref 1, attachment A, pp 78, 82, 85.

It is felt however, that the three can be combined (or at least expand) into one payload/mission.

This payload also has a great potential for demonstrating or determining the usefulness of man in space to observe, analyze, and select "next" target.

The requirement parameters are generic and based on such payloads as GDCD 0173, 0174, etc.

The first-flight date (schedule) was chosen based on the necessity of having it started as soon as feasible.

PAYLOAD ELEMENT NAME
Geoscience - Geology Remote Sens

CODE GDCD0177

TYPE
- [x] Science & Applications (non-commercial)
- [ ] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A) 2

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- [ ] Operational
- [ ] Approved
- [ ] Planned
- [x] Candidate
- [ ] Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 1800

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

OBJECTIVE Acquire data on composition, structure, and chronology to reconstruct the geologic evolution of an area based on remote sensing using visible and infrared imagery and microwave radar simultaneously or near simultaneously to eliminate temporal variables such as temperature, soil moisture, and vegitation cover.

DESCRIPTION

The payload consists of many large instruments for Earth viewing, i.e., multifrequency/multipolraization/multiple look synthetic aperture radar, multispectral programmable imaging spectrometer, thermal IR multispectral scanner, scanning lasar altimeter, polar subsurface sounder, active fluorescence spectrometer, luminescense detector.

CODE GDCD0177

ORBIT CHARACTERISTICS

Apogee, km 500 Perigee, km 500 Tolerance + 100 - 200
Inclination, deg 90 Tolerance + 10 - 10
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec 6 Field of view, deg ±30 nadir
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	10,000	
Standby		
Peak		

☐ Continuous

Voltage, V 28 Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 300,000 Downlink Frequency (MHZ) ____

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CODE GDCD0177

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min 10 max 35

non-operational min ___ max ___

Heat Rejection, w operational min ___ max ___

non-operational min ___ max ___

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ___ W,m ___ H,m ___ Stowed

L,m 30 W,m 30 H,m 3 Deployed

Launch mass, kg 2000

Consumables Types ___

Acceleration sensitivity, g min ___ max ___

CREW REQUIREMENTS

Crew Size 1 Task Assignment Instrument Selection/Observe

Skills (See Table B)

SKILL	5					
LEVEL	2					
Hrs/Day	0.2					

EVA ☒ YES ☐ NO Reason Subsystem Changeout Hrs/EVA 8

SERVICING/MAINTENANCE

SERVICE: Interval, days ___ Consumables, kg ___

Returnables, kg ___ Man Hours ___

CONFIGURATION CHANGES: Interval, day 365 Man/Hrs Req. 4

Deliverables, kg ___ Returnables, kg ___

SPECIAL CONSIDERATIONS/See Instructions

Ground track repeat cycle: seasonal

Major susceptibilities: RFI at radar frequencies, contaminants, particulate, gaseous condensates on optical surfaces, scattered light for stability and printing requiring stable mount.

GDCD CODE 0177 ELEMENT NAME GEOSCIENCE-GEOLOGY REMOTE SENSING

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER* ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1990 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.2 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 365 DAYS TOTAL RECONFIGS. 4

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 2

☐ NOT APPLICABLE EVA HRS PER RECONFIG. 2

EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

DATE(S) 1995 INT. HRS. ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

*Free flyer accommodation is an alternate mode, and if used will require re-evaluation of all requirements.

1. Station OPS
3. Monitor
4. Subsystem changeout
5. Station OPS

TOTAL EVA HRS 8

Code: GDCD 0177

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Geoscience-Geology Remote Sensing

Reference Documents:

1. Science and Applications Requirements for Space Station, Draft, Provided 17 November 1982 at Interim Review at NASA Headquarters

Narrative:

The goal of geology is to acquire sufficient information on composition, structure, and chronology to reconstruct the geologic evolution of an area. Remote sensing is particularly useful for determining structure and lithology. By the advent of the space station in the early 1990s, we will have learned how to use the visible and infrared imagery obtained by Landsat to discriminate and identify rock units and map surface structure. Significant advances in radar remote sensing will have been made toward understanding the effect of variable incidence angles, wavelengths, and polarizations on the interpretability of orbital radar imagery. The next step will be to combine these two types of data in a controlled manner (registered and calibrated) to determine what geological information can be obtained from the combined data sets. The advantage offered by the space station is its capability of supporting many large instruments so that data may be acquired over a particular area simultaneously with all instruments (from Ref 1, para 3.1.3.2.1).

The following measurements will be considered:

Visible and reflected infrared methods obrain measurements of reflected solar radiation at wavelengths of 0.4-2.5 micrometers.

Thermal infrared methoos measure emitted thermal radiation, primarily in the 8-14 micrometer region.

Radar imaging techniques measure backscatter microwave radiation at wavelengths of 1-50 cm.

The instrument and mission requirements were also obtained from Ref (1), paragraph 3.1.3.2.1.

Code: GDCD 0177 PAYLOAD ELEMENT SYNTHESIS

Geoscience - Geology Mass Estimate

1.	SAR -	300 kg
2.	Imaging Spectrometer	500
3.	Multispectral Scanner	(included in 1)
4.	Scanning laser altimeter	185
5.	Polar Subsurface Sounder	300
6.	Active Fluorescence Spectrometer	300
7.	Luminescence detector	300
	+ Growth	115 kg
		Total: 2,000 kg

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PAYLOAD ELEMENT NAME
Imaging Radar for ER Inventory

CODE GDCD0179

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1996
No. of flights 1
Duration of Flight, days 1095

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 2

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 9

OBJECTIVE

Monitor soil moisture distribution, crop classification, snow dynamics, geological maping, etc.

DESCRIPTION

Imaging radar using synthetic aperture radar as primary instrument. (This payload may be integrated with the operational land systems GDCD 0172 payload if it cannot go earlier.)

CODE G D C D 0 1 7 9

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 100 - 100
Inclination, deg 57 Tolerance + 33 - 28.5
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec 360 Field of view, deg ±30 nadir
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	5000	
Standby	300	
Peak	7500	

☐ Continuous

Voltage, V DC Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☒ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) 140,000
Data Dump Frequency (Per Orbit) 1
Recording Rate (KBPS) 20,000 Downlink Frequency (MHZ) ____

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CODE GDCD0179 Page 3 of 3

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min 10 max 35
non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 6 W,m 2 H,m 2 Stowed
L,m 15 W,m 3 H,m 2 Deployed

Launch mass, kg 2000

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 1 Task Assignment Select/Adjust Instruments

Skills (See Table B)

SKILL	5					
LEVEL	2					
Hrs/Day	0.2					

EVA ☐ YES ☒ NO Reason ____ Hrs/EVA ____

SERVICING/MAINTENANCE

SERVICE: Interval, days ____ Consumables, kg ____
Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0179 ELEMENT NAME IMAGING RADAR FOR EARTH RESOURCES INVENTORY

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER * ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1996 INT. HRS ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ______ DAYS TOTAL SERVICES ______

   ☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

   ☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

   EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.2 HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ______ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) 1999 INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

*Free flyer accommodation is an alternate mode, and if used will require re-evaluation of all requirements.

1. Station OPS
3. Monitor
5. Station OPS

TOTAL EVA HRS 0

Code: GDCD 0179

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Imaging Radar for Earth Resources Investigating and Monitoring

Reference Documents:

1. Strawman Payload Data for Science and Applications Space Platforms, Final Report, SP80-MSFC-2403, January 1980

Narrative:

Soil moisture distribution, including depth, can be determined by spaceborne radar. Also the radar is useful in crop classification, snow dynamics, geological maping, etc. The primary instrument is a synthetic aperture radar.

The payload and characteristics were suggested by Dr. Fawwaz T. Ulaby of the University of Kansas.

Instrument size, etc., were obtained as typical and scaled up from Ref 1, p 60.

Schedule, crew requirements, and servicing requirements were estimated based on similarity to other payloads of this type.

PAYLOAD ELEMENT NAME
Freeflying Imaging Radar Exp

CODE
G D C D 0 1 8 0

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1992
No. of flights 1
Duration of Flight, days 2440

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 2

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 2

OBJECTIVE

Use synthetic aperture radar (SAR) as primary sensor to characterize ice, ocean, and land features, i.e., state of vegitation and superficial geological features. (Potential joint endeavor between USA and Canada.)

DESCRIPTION

Synthetic aperture radar (SAR) freeflying with large antenna (8 × 2.8m) in polar orbit with 150 Km swath width, 25m resolution, and global coverage every 3 days. This is the FIREX (free-flying imaging radar experiment).

CODE G D C D 0 1 8 0

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 50 - 25
Inclination, deg 90 Tolerance + 10 - 10
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec 3600 Field of view, deg ±3 × 30 nadir
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	7000	
Standby	100	
Peak	10,000	

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 120,000 Downlink Frequency (MHZ) ______

CODE G D C D 0 1 8 0

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 4 W,m 4 H,m 4 Stowed
L,m 4 W,m 8 H,m 12 Deployed

Launch mass, kg 2000

Consumables Types Propellants

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days 1220 Consumables, kg 200
Returnables, kg ______ Man Hours 16

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Axis of antenna along velocity vector.

On-board data processing or TDRSS work-around.

Canada has an interest from an arctic ice standpoint and is planning to launch a polar ice-monitoring SAR vehicle in 1990 (IEEE spectrum Nov 1482, Elachi and Granger).

GDCD CODE 0180 ELEMENT NAME FREE FLYING IMAGING RADAR EXP (FIREX)

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1992 INT. HRS ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 1220 DAYS TOTAL SERVICES 1

☒ TMS/OTV ~~REQUIRED~~ ALTERNATE STATION HRS PER SERVICE 16

☐ NOT APPLICABLE EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

______ HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☒ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) 1999 INT. HRS. ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

This payload element assumes accommodation on a platform or Leasecraft type spacecraft which has orbit transfer propulsion

2. Spacecraft propellant

TOTAL EVA HRS 0

Code: GDCD 0180 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Free-Flying Imaging Radar Experiment (FIREX)

Reference Documents:

1. Space Station NAAO Study, Orientation Meeting Handout NASA Headquarters, 14-15, September 1982

2. Spaceborne Imaging Radar Probe "In-Depth," IEEE Spectrum, November 1982, Elachi & Granger of JPL.

Narrative:

This payload is a free-flying satellite that will be used for imaging ocean, ice & land features on a global basis. It has a high probability of being a joint effort between Canada and USA. The Canadian counterpart is RADARSAT. Weight assumes no orbit transfer propulsion or support resources such as could be provided by a Leasecraft-type spacecraft or platform accommodation.

This payload element assumes accommodation on a platform or Leasecraft type spacecraft which has orbit transfer propulsion.

The basic data on requirements were taken from Ref 1, pp 8-18 and supporting data were obtained from Ref (2).

PAYLOAD ELEMENT NAME
Z-Continuous Coverage

CODE G D C D 0 1 8 1

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
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P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1996
No. of flights 1
Duration of Flight, days 720

TYPE
- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 3

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 2

OBJECTIVE

To provide a highly adaptable civil space facility in low Earth Orbit for long term multidisciplinary scientific study of the Earth and the development of related technology (System Z).

DESCRIPTION

The initial system Z continuous coverage representative instruments are assembled on a Free Flying spacecraft which provides on-orbit resources as well as propulsion capability. Periodic spacecraft servicing, and man-tended instrument related functions such as sensor replacement and calibration are envisioned. The representative instruments are required to obtain systematic global observations at the highest possible frequency for weather and climate studies. The instrument complement is: imaging radiometers (2), thematic mapper, radar altimeter, ocean wave directional spectrometer, scanning multifrequency MW radiometer, radar scatterometer, IR/microwave sounder, multifrequency microwave limb sounder, UV spectrometer limb sounder, cryo IR gas correlation spectroradiometer, data collection system, solar monitoring package.

CODE GDCD0181

ORBIT CHARACTERISTICS

Apogee, km 1000 Perigee, km 1000 Tolerance + 0 – 600
Inclination, deg 100 Tolerance + 0 – 4
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	3160	24
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☒ Uplink Req.: Command Rate (KPS) ____ Frequency (MHZ) ____
☒ On-Board Data Processing Required
Description
Generate/Modify Observational Sequences; Special Requests & Priority Interrupt Implementation

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 125,000 Downlink Frequency (MHZ) ____

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CODE GDCD0181

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 16	W,m 4.5	H,m 4.5	Stowed
L,m 16	W,m 45.0	H,m 4.5	Deployed

Launch mass, kg 8578

Consumables Types Propellants

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☒ YES ☐ NO Reason Inst Calib/Change Hrs/EVA 20

SERVICING/MAINTENANCE

SERVICE: Interval, days 365 Consumables, kg 1860
Returnables, kg ______ Man Hours 16

CONFIGURATION CHANGES: Interval, day 365 Man/Hrs Req. 24
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

May require 2 satellites phased 180 degrees apart in 500 KM orbit or one satellite at 500 Km at >1000 Km to obtain global weather coverage. Deployed width includes solar array.

GDCD CODE 0181 ELEMENT NAME Z-CONTINUOUS COVERAGE

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1996 INT. HRS ____ EVA HRS 8 EVA CREW 1

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 365 DAYS TOTAL SERVICES 1

☒ TMS/OTV ~~REQUIRED~~ ALTERNATE STATION HRS PER SERVICE 16

☐ NOT APPLICABLE EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

____ HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☒ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 365 DAYS TOTAL RECONFIGS. 1

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 12

☐ NOT APPLICABLE EVA HRS PER RECONFIG. 12

EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

DATE(S) 1998 INT. HRS. ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

This payload element has orbit transfer propulsion

1. Instrument calibration
2. Satellite service for propellants may be required - if needed, could be performed concurrent with Item 4.

4. Instrument or instrument module changeout.

TOTAL EVA HRS 20

Code: GDCD 0181

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Z-Continuous Coverage

Reference Documents:

1. Science and Applications Requirements Supplement, System Z, NASA HQ, 11 January 1983.

Narrative:

The system Z continuous coverage payload element is described in Ref (1) as the "starter set" of the system Z series of interdisciplinary earth observations conducted from high inclination orbit. A free-flying accomodation is described, Ref (1).

Crew related data, service data and launch mission duration data are derived. Power level is for science payload only. The deployed width includes solar panels.

The payload is assumed to be delivered to low altitude orbit by the shuttle. Final orbit would be achieved using spacecraft propulsion. Servicing could use TMS/OTV.

Remaining data from Ref 1

PAYLOAD ELEMENT SYNTHESIS

INSTRUMENT	WT (kg)	POWER (kW)	DATA RATE (kbps)	CHARACTERISTICS	SPECIAL REQUIREMENTS
1. MODERATE FOV IMAGING RADIOMETER (MFIR)	100	0.1	30,000	50-12,000 m RES, 400-800 km SWATH WIDTH, 11 BANDS 0.4-12.5 μm 100-500 nm RES	0.1 mrad POINTING STABILITY CRYO DET T
2. WIDE FOV IMAGING RADIOMETER (WFRR + 1 AVHRR + OCI)	50	0.05	10,000	300-600 m RES, 1000-2000 km SWATH 10-20 nm BANDS 0.4-0.6 8 VIS-TIR BANDS, 0.4-12.5 μm, 200-1000 nm RES	0.6 mrad POINTING STABILITY CRYO DET T
3. TM EQUIVALENT	250	0.35	85,000	30 m RES, 185 nm SWATH, 80 nm - 1200 nm RES 7 BANDS, 0.4-12.5	0.020 mrad STABILITY CRYO DET T
4. RADAR ALTIMETER	150	0.2	10	1.2-12 km FOOTPRINT, NADIR-LOOKING, 13 GHz, 1 m ANT., MODIFIED FOR SIMULTANEOUS OPT MEAS	NONE
5. OCEAN WAVE DIRECTIONAL SPECTROMETER (OWDS)	100	0.1	1	14 GHz	1M CONICAL SCAN (10° CONE ANGLE)
6. SCANNING MULTIFREQUENCY MICROWAVE RADIOMETER (LAMMR)	300	0.5	200	6-50 GHz	4M CONICAL SCAN (60° CONE ANGLE)
7. RADAR SCATTEROMETER	150	0.2	10	13 GHz, 100° FOV	6 2M STICK ANTENNAS

266.592-415

Representative Payload

Code: GDCD 0181

PAYLOAD ELEMENT SYNTHESIS

INSTRUMENT	WT (kg)	POWER (kW)	DATA RATE (kbps)	CHARACTERISTICS	SPECIAL REQUIREMENTS
8. IR/MICROWAVE SOUNDER (HIRS + MSU + SSN) SUSSKIND/CHAHINE	SIZE 1.5x 3x 0.8M 380	0.32	6.6	1 FOV 5 km IR, 25 km μWAVE SCAN ±45° 28 IR CHANNELS 3.7 16.5 μm 20 μWAVE CHANNEL., 22-60 GHz	AMTS + AMSU
9. MULTIFREQUENCY MICROWAVE LIMB SOUNDER	100	0.4	10	10-200 GHz	LIMB POINTABLE
10. UV SPECTROMETER LIMB SOUNDER	100	0.2	10	SIMILAR TO NIMBUS SBUV/TOMS	LIMB POINTABLE
11. CRYO IR GAS CORRELATION SPECTRORADIOMETER	300	0.5	200	2.5-25μ COMBINATION OF GAS CORRELATION AND CRYO COOLED IR SPECTROMETERS	LIMB POINTABLE
12. DATA COLLECTION AND LOCATION SYSTEM (DCLS)	200	0.1	10	50 KHz B.W. AT 400 MHz	4 10M BOOMS 120° FOV DISH
13. SOLAR MONITORING PACKAGE					SUNWARD LOOKING
LOW RES SPECTROMETER	125	0.13	1	EUV AND UV	
BROADBAND RADIOMETER	20	0.01	0.17	VIS AND IR 0.4-50 m	
TOTALS	2325 kg	3.16 kW	125,000 kbps (125 Mbits)		

266.592-416

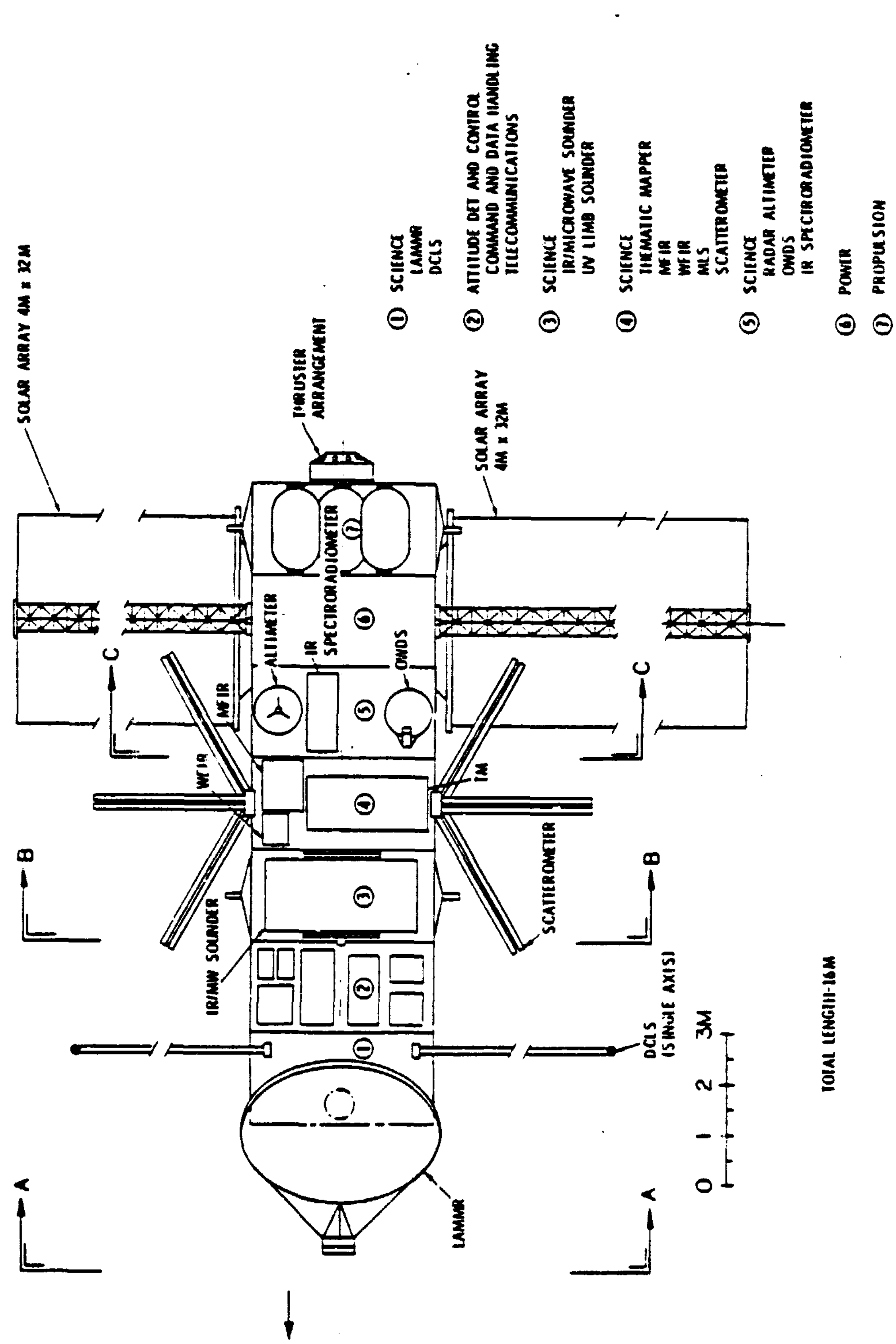
Representative Payload (contd)

SUBSYSTEM	MASS (kg)	POWER (kW)
TELECOM	83	0.25
POWER	830	0.20
COMMAND/DATA	150	0.75
DATA STORAGE	142	0.50
AACS	1100	0.92
PROP (DRY)	538	0.31
STRUCTURE, CABLING, THERMAL CONTROL	1550	0.50
PAYLOAD	2325	3.16
SUBTOTAL:	6718	6.59
PROPELLANT*	1860	
LAUNCH WT	8578	

*3 LMSC 1.57 x 0.93 m N_2H_4 TANKS

266.532-417

Configuration Sizing



System Z On Orbit Configuration

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PAYLOAD ELEMENT NAME
Z-Hydrologic Cycle Priority

CODE G D C D 0 1 8 2

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 1998
No. of flights 1
Duration of Flight, days 720

TYPE

☒ Science & Applications (non-commercial)
☐ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 3

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 2

OBJECTIVE To provide a highly adaptable civil space facility in Low Earth Orbit for long term multidisciplinary scientific study of the Earth and the development of related technology (system Z). This so called "Red" payload has been chosen to serve the priority needs of the hydrologic cycle including sea ice, biomass, land cover/land use and provide major contributions in the areas of climate continental geology and atmospheric circulation.

DESCRIPTION This payload element provides a plateau in system and evolution. A mix of continuous coverage and special coverage instruments are assembled on a Free Flying spacecraft which provides on-orbit resources as well as propulsion capability. Periodic spacecraft servicing and man-tended functions such as replacement and calibration of sensors are envisioned. The instrument complement to accomplish the objectives are: wide FOV imaging radiometer, scanning multi-frequency microwave radiometer, IR microwave sounder, data collection system (continuous coverage instruments) as well as the following special coverage instruments - hi resolution imaging radiometer, multi-frequency, multi-polarization, multi-lock angle synthetic aperture radar.

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CODE G D C D 0 1 8 2

ORBIT CHARACTERISTICS
Apogee, km 1000 Perigee, km 1000 Tolerance + 0 - 600
Inclination, deg 100 Tolerance + 0 - 4
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION
View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec ______ Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER
☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	2370	24
Standby		
Peak	7970	

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS
Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other ______
☐ Encryption/Decryption Required
☒ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☒ On-Board Data Processing Required
Description
Generate /Modify Observation Sequences; Special Requests & Priority Interrupt Implementation

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 300,000 Downlink Frequency (MHZ) ______

CODE G D C D 0 1 8 2 —

THERMAL

☐ Active ☐ Passive

Temperature, deg C — operational min ____ max ____

non-operational min ____ max ____

Heat Rejection, w — operational min ____ max ____

non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 16 W,m 4.5 H,m 4.5 Stowed

L,m 31 W,m 45.0 H,m 4.5 Deployed

Launch mass, kg 8708

Consumables Types Propellants

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size ____ Task Assignment ____

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☒ YES ☐ NO Reason Inst Calibr/Change Hrs/EVA 20

SERVICING/MAINTENANCE

SERVICE: Interval, days 365 Consumables, kg 1860

Returnables, kg ____ Man Hours 16

CONFIGURATION CHANGES: Interval, day 365 Man/Hrs Req. 24

Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Deployed length includes synthetic aperture radar (15 M); deployed width includes solar array. Data relay rate is time shared not to exceed 300 MBPS; >600 MBPS direct to ground. May require two satellites phased 180 degrees in 500 Km orbit or one satellite at 500 Km and one at >1000 Km to obtain global coverage.

GOCO CODE 0182 ELEMENT NAME Z-HYDROLOGIC CYCLE

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1998 INT. HRS ______ EVA HRS 8 EVA CREW 1

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 365 DAYS TOTAL SERVICES 1

☒ TMS/OTV ~~REQUIRED~~ ALTERNATE STATION HRS PER SERVICE 16

☐ NOT APPLICABLE EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

______ HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA).

☒ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 365 DAYS TOTAL RECONFIGS. 1

☒ TMS/OTV ~~REQUIRED~~ ALTERNATE STATION HRS PER RECONFIG. 12

☐ NOT APPLICABLE EVA HRS PER RECONFIG. 12

EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

DATE(S) 2000 INT. HRS. ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

This payload element has orbit transfer propulsion

1. Instrument calibration
2. Satellite service for propellants may be required. If needed, could be performed concurrent with Item 4.
4. Instrument or instrument module changeout.

TOTAL EVA HRS 20

Code: GDCD 0182 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Z-Hydrologic Cycle Priority

Reference Documents:

1. Science and Applications Requirements Supplement, System Z, NASH HQ, 11 January 1983.

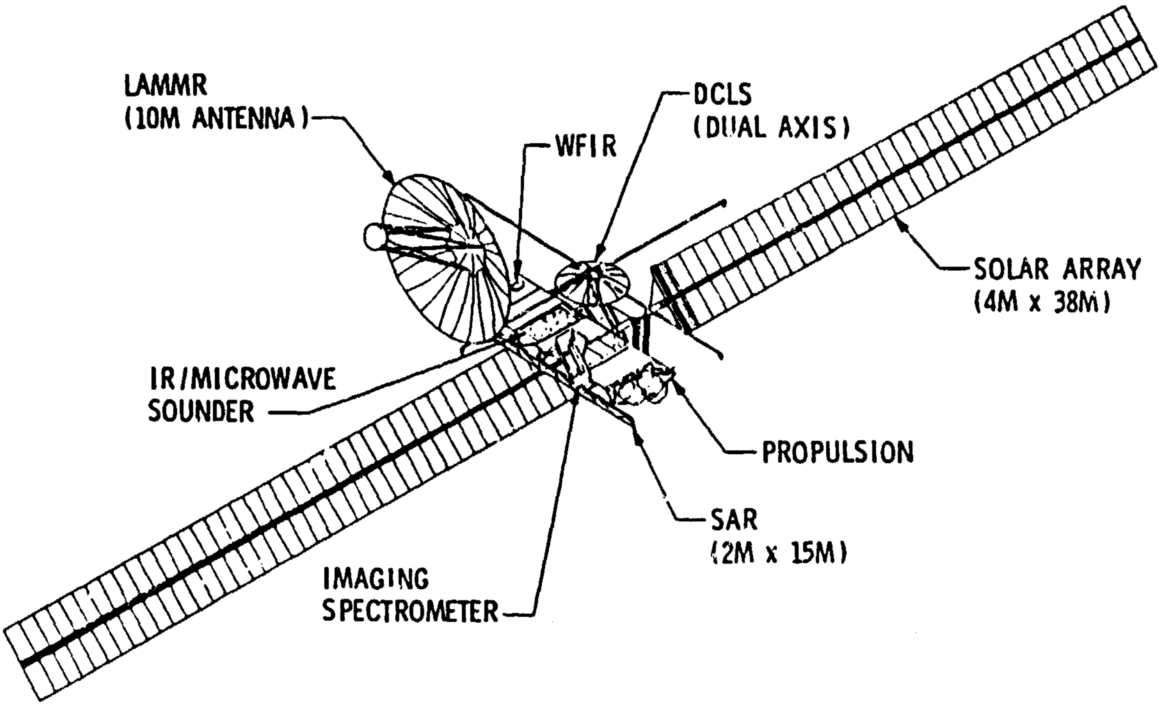
Narrative:

The system Z hydrologic priority payload element is described in Ref (1) as the "red" payload of the system Z series of interdisciplinary Earth observations conducted from high inclination orbit. A free-flying accommodation is described (Ref 1).

It was assumed that this payload element was delivered by the shuttle. Final orbit would be achieved using spacecraft propulsion. Servicing could use TMS/OTV. A possible approach is to perform major reconfiguration of GDCD 0181 on the ground (or possibly on orbit) after about two years of operation.

Crew-related data, service data, and launch/mission duration data are derived. Power level is for instruments only and is derived assuming that for peak power all red payload instruments are "on", and for average power all instruments except special coverage instruments are "on". Relay data rate is assumed to be time-shared. Maximum data rate to the ground will be 600 MBPS.

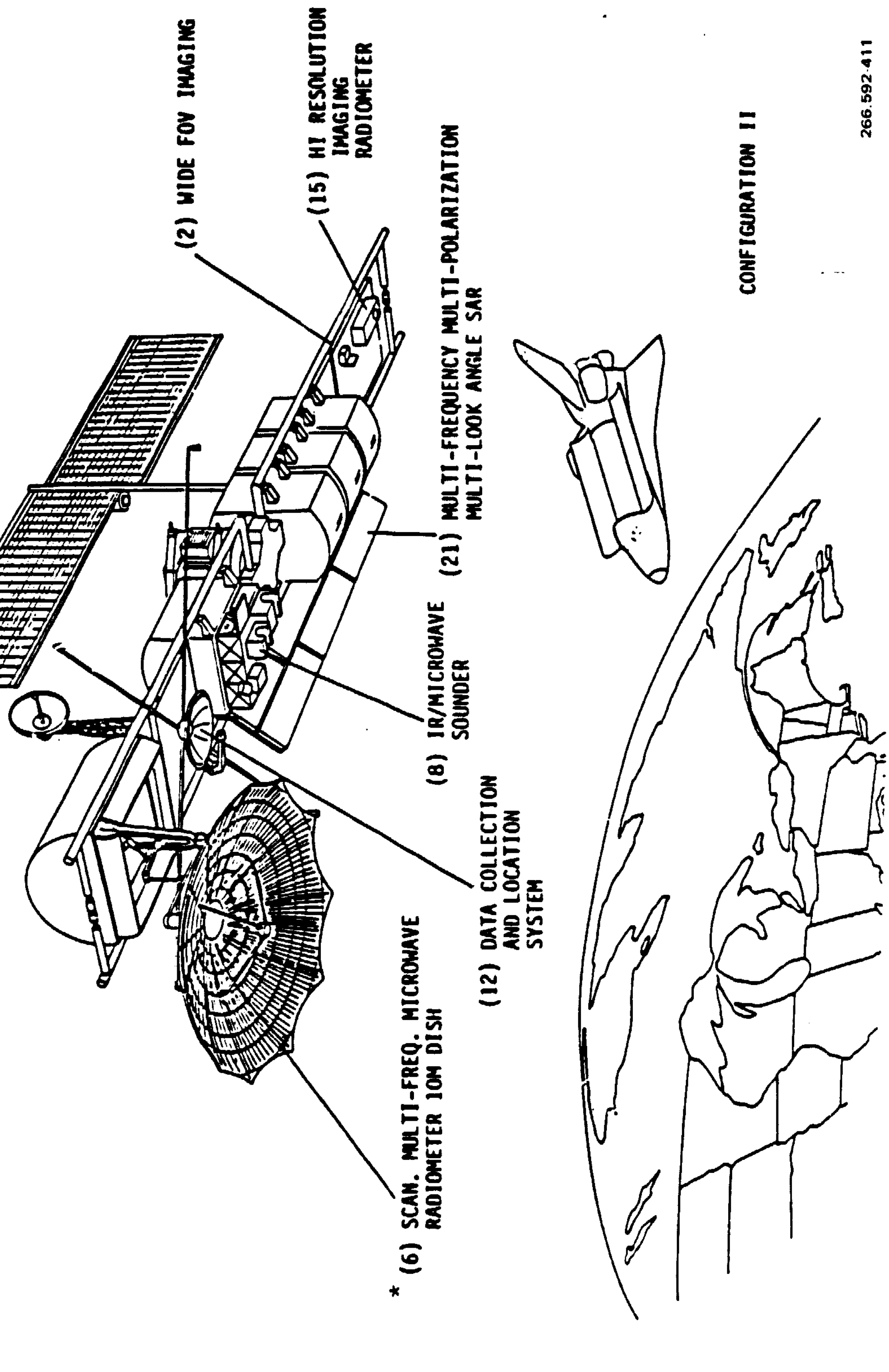
Remaining data from Ref 1



System Z Red Payload

Code: GDCD 0182

PAYLOAD ELEMENT SYNTHESIS



Red Payload Instruments

*See Table 0184-1 for instrument description.

Code: GDCD 0182

PAYLOAD ELEMENT SYNTHESIS

SUBSYSTEM	MASS (kg)	POWER (kW)
TELECOM	83	0.25
POWER	925	0.31
COMMAND/DATA	150	0.75
DATA STORAGE	142	0.50
AACS	1100	0.92
PROP (DRY)	538	0.31
STRUCTURE, CABLING, THERMAL CONTROL	1580	0.50
PAYLOAD	2330	7.97
SUBTOTAL:	6848	11.51
PROPELLANT	1860	
LAUNCH WT	8708	

*3 LMSC 1.57 m x 0.93 m N_2H_4 TANKS

266.592-418

Configuration Sizing Red Payload

PAYLOAD ELEMENT NAME
Z-Special Coverage

CODE G D C D 0 1 8 3

TYPE
- [x] Science & Applications (non-commercial)
- [ ] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A) 3

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- [ ] Operational
- [ ] Approved
- [ ] Planned
- [x] Candidate
- [ ] Opportunity

First flight, yr 2000
No. of flights 1
Duration of Flight, days 720

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 2

OBJECTIVE

To provide a highly adaptable civil space facility in Low Earth Orbit for long term multidisciplinary scientific study of the Earth and the development of related technology (System Z).

DESCRIPTION The growth version system and configuration includes special coverage representative instruments assembled on a Free-Flying spacecraft which provides on-orbit resources as well as propulsion capability. Periodic spacecraft servicing and man-tended instrument related functions such as sensor replacement and calibration are envisioned. The representative instruments are time-shared between disciplines and include both advanced technique development and research tasks and systematic global observations which can be separated by weeks or months. The instrument complement is: imaging spectrometer, high resolution imaging radiometer, thermal IR multispectral imager, scanning laser ranger, multifrequency LIDAR facility, real aperture radar facility, precision fast scanning large aperture microwave radiometer scatterometer, multifrequency, multipolarization, multilook angle synthetic aperture radar.

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CODE G D C D 0 1 8 3

ORBIT CHARACTERISTICS

Apogee, km 1000 Perigee, km 1000 Tolerance + 0 - 600
Inclination, deg 100 Tolerance + 0 - 4
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec ______ Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	10,000	
Standby		
Peak	10,000	

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other ______
☐ Encryption/Decryption Required
☒ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☒ On-Board Data Processing Required
Description
Generate/Modify Observational Sequences; Special Requests & Priority Interrupt Implementation

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 300,000 Downlink Frequency (MHZ) ______

CODE G D C D 0 1 8 3

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 17	W,m 4.5	H,m 4.5	Stowed
L,m 33	W,m 45.0	H,m 4.5	Deployed

Launch mass, kg 18,821

Consumables Types Propellants

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☒ YES ☐ NO Reason Inst Calibr/Change Hrs/EVA 32

SERVICING/MAINTENANCE

SERVICE: Interval, days 365 Consumables, kg 3720
Returnables, kg ______ Man Hours 16

CONFIGURATION CHANGES: Interval, day 365 Man/Hrs Req. 24
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Deployed length includes synthetic aperture radar (15m); deployed width includes solar array. Data relay rate is time-shared not to exceed 300 MBPS; 1,000 MBPS direct to ground. May require 2 satellites phased 180 degrees apart in 500 Km orbit, or one satellite at 500 Km and one at >1000 Km to obtain global coverage.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0183 ELEMENT NAME Z-SPECIAL COVERAGE

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 2000 INT. HRS ____ EVA HRS 8 EVA CREW 1

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 365 DAYS TOTAL SERVICES 1

☒ TMS/OTV ~~REQUIRED~~ ALTERNATE — STATION HRS PER SERVICE 16

☐ NOT APPLICABLE — EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

____ HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☒ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 365 DAYS TOTAL RECONFIGS. 1

☒ TMS/OTV ~~REQUIRED~~ ALTERNATE — STATION HRS PER RECONFIG. 12

☐ NOT APPLICABLE — EVA HRS PER RECONFIG. 12

EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

This payload element has orbit transfer propulsion.

1. Instrument calibration
2. Satellite service for propellants may be required. If needed, could be performed concurrent with Item 4.
4. Instrument or instrument module changeout.
5. Operations continue after year 2000.

TOTAL EVA HRS 20

Code: GDCD-0183 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Z-Special Coverage

Reference Documents:

1. Science and Applications Requirements Supplement, System Z, NASA HQ, 11 January 1983.

Narrative:

The system Z special coverage payload element is described in Ref (1) as the growth version of the system Z series of interdisciplinary earth observations conducted from high inclination orbit. A free-flying accomodation is described in Ref (1).

The delivery weight of this payload element will require both the shuttle and on board propulsion. Servicing will be by the OTV.

The payload could possibly be reconfigured from GDCD 0182 on the ground (or on orbit) after about two years of operation.

Crew, service weight, and launch/mission duration data are derived. Power level is for instruments only and is time shared so as not-to-exceed 10 KW (Ref 1). Relay data rates are time-shared to 300 bps level (Ref 1).

Remaining data derived.

PAYLOAD ELEMENT SYNTHESIS

From Ref 1.

INSTRUMENT	WT (kg)	POWER (kW)	DATA RATE (kbps)	CHARACTERISTICS	SPECIAL REQUIREMENTS
14. IMAGING SPECTROMETER	500	2	300,000	10M SPATIAL RES, 20 nm SPECTRAL, 0.4-2.5 μm, 10 km SWATH (240 BANDS)	2 π POINTABLE WITH 0.01 mrad STABILITY CRYO DET
15. HI RES IMAGING RADIOMETER (PHIR)	600	0.6	300,000	5 10M SPATIAL RES, 100 km SWATH, 24 BANDS BETWEEN 0.4-12.' μm 20 nm 20 nm SPECTRAL	2 π POINTABLE WITH 0.1 mrad STABILITY CRYO DET T
16. THERMAL IR MULTI-SPECT. IMAGER (TIMS)	300	0.2	10,000	8-13, 100M SPATIAL RES, 50 km SWATH 200-500 nm	2 π POINTABLE CRYO DET T
17. SCANNING LASER RANGE (LR + SLA)	500	10	300	0.5 3M VERT RES, 50 m HORIZONTAL	SCAN ±45° CROSS-TRACK
18. MULTIFREQUENCY LIDAR FACILITY	2300	3-10	2000	0.3-13, 1.2M DIA TELESCOPE, 3M LONG	LASER CHANGEOUT 45° CONICAL SCAN MIRROR
19. REAL APERTURE RADAR FACILITY (CP-1)	1500	1	1000	6-35 GHz	10M CONICAL SCAN (0-80° CONE ANGLE) ANT., 30 rpm

266.592-419

INSTRUMENT	WT (kg)	POWER (kW)	DATA RATE (kbps)	CHARACTERISTICS	SPECIAL REQUIREMENTS
20. PRECISION FAST SCANNING LARGE APERTURE MICRO-WAVE RADIOMETER/ SCATTEROMETER (PF)	1000	0.5	100	30-200 GHz	10 mrad POINTING ACCURACY 4M CONICAL SCAN (0-80° CONE ANGLE) ANT., 30 rpm
21. MULTIFREQUENCY, MULTIPOLARIZ, MULTILOOK ANGLE SAR	800	5	300,000	25M RES, 100 km SWATH	2 x 15 m PLANAR ARRAY POINTABLE 0-60° CROSS TRACK (ONE SIDE)
TOTALS	7500	30 (TIME-SHARED INTO 10 kW)	912,000 kbps (TIME-SHARED INTO 300 Mbps LINK)		

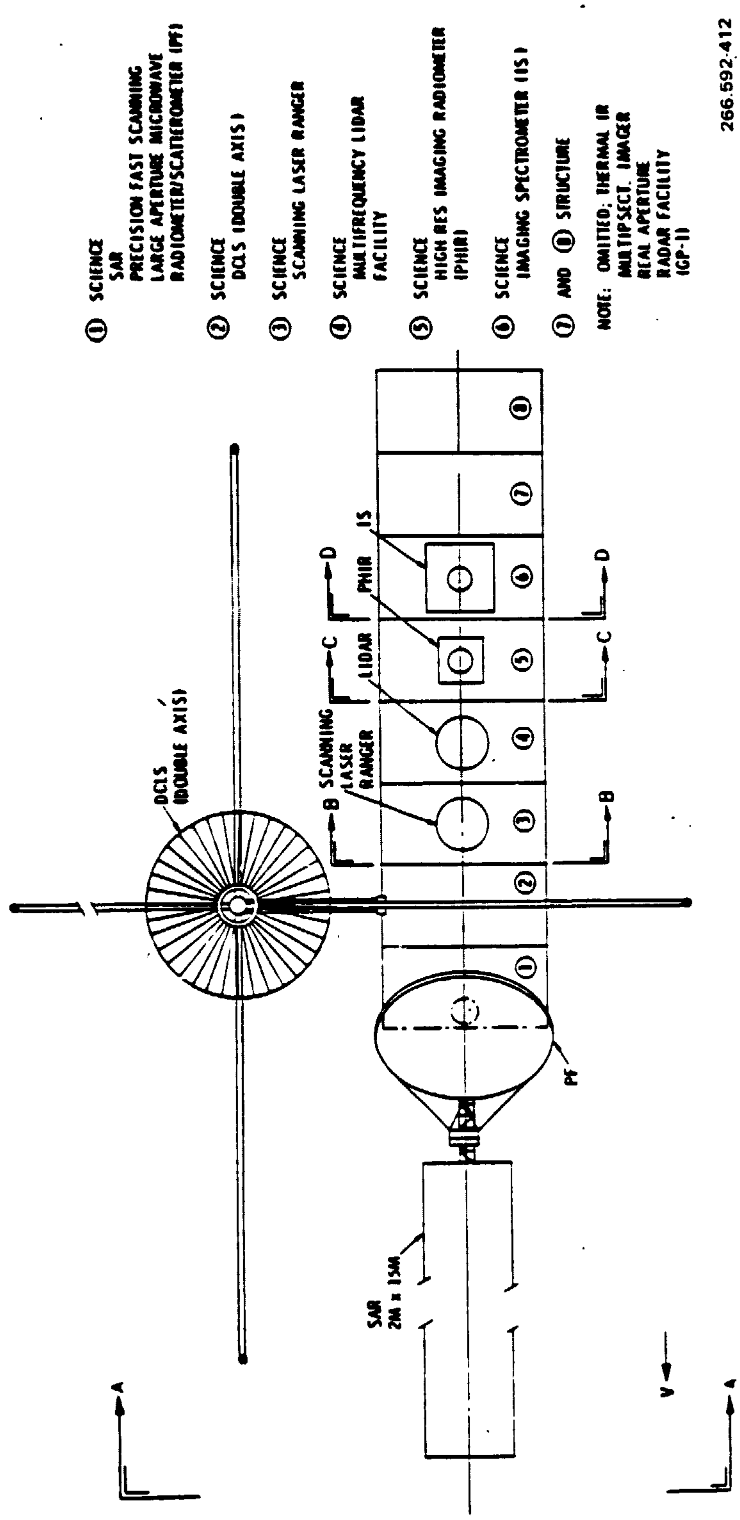
266.592-420

Representative Payload Special Coverage Instruments

Code: GDCD 0183

PAYLOAD ELEMENT SYNTHESIS

From Ref 1.



System Z On Orbit Configuration Growth Version

Code: GDCD 0183 PAYLOAD ELEMENT SYNTHESIS (Contd)

Payload Element Weight Estimate*

		Weight (kg)
Telecom		83
Power		1250
Command/Data		150
Data Storage		.142
A ACS		1900
Prop (dry)		1076
Structure, Cabling, Thermal Control		3000
Payload		7500
	Subtotal	15101
Propellant (N_2H_4)		3720
Launch Weight		18821

(*Derived from Ref 1)

PAYLOAD ELEMENT NAME
Z-Cont and Special Coverage

CODE G D C D 0 1 8 4

TYPE
- [x] Science & Applications (non-commercial)
- [ ] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A) 3

CONTACT
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Address: General Dynamics Convair Division
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Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- [ ] Operational
- [ ] Approved
- [ ] Planned
- [x] Candidate
- [ ] Opportunity

First flight, yr 2002
No. of flights 1
Duration of Flight, days 3650

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 8

OBJECTIVE

To provide a permanent, highly adaptable civil space facility in low Earth orbit for the scientific study of the Earth and the continuing development of related technology.

DESCRIPTION

The system Z full payload contains 20 sensor packages. Many operating simultaneously in the UV to MW wavelengths, to support interdisciplinary research in Earth sciences. The payload is accommodated on a manned polar orbiting space station to provide global coverage, with man fulfilling the role of scientist, construction/servicing crew, and coordinator with ground-based researchers.

CODE G D C D 0 1 8 4

ORBIT CHARACTERISTICS
Apogee, km 500 Perigee, km 500 Tolerance + 500 - 100
Inclination, deg 97.5 Tolerance + 2.5 - 7.5
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required,m/s ______

POINTING/ORIENTATION
View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy,arc sec 412 Field of view, deg 180
Pointing Stability (Jitter)arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER
☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	5000 - 3000	
Standby	1500	
Peak	40,000	

☐ Continuous

Voltage,V ______ Frequency,Hz ______

DATA/COMMUNICATIONS
Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other ______
☐ Encryption/Decryption Required
☒ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☒ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☒ Digital ☒ Hrs/Day 24
Film (Amount) ______ Voice (Hrs/Day) 4
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) 10 E06
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 300,000 Downlink Frequency (MHZ) 14,000

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OF POOR QUALITY

CODE G D C D 0 1 8 4 **Page 3 of 3**

THERMAL
☐ Active ☒ Passive
Temperature, deg C operational min ______ max ______
non-operational min ______ max ______
Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS
Location: ☐ Internal ☒ External ☐ Remote
Equipment ID/Function ☐ Pressurized ☒ Unpressurized
L,m 18 W,m 4.5 H,m 4.5 Stowed
L,m 38 W,m 22.0 H,m 4.5 Deployed
Launch mass, kg 14,260
Consumables Types Cryogenics
Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS
Crew Size 1
Skills (See Table B) Task Assignment Ope[illegible]e Facility

SKILL	4					
LEVEL	3					
Hrs/Day	2					

EVA ☒ YES ☐ NO Reason Assy, SVC, Update, Calib. Hrs/EVA 203

SERVICING/MAINTENANCE
SERVICE: Interval, days 90 Consumables, kg 30
Returnables, kg 0 Man Hours 3
CONFIGURATION CHANGES: Interval, day 180 Man/Hrs Req. 2
Deliverables, kg 200 Returnables, kg 200

SPECIAL CONSIDERATIONS/See Instructions

GOCD CODE 0184 ELEMENT NAME Z-CONTINUOUS AND SPECIAL COVERAGE

ACCOMODATION: [X] ATTACHED [ ] FREE FLYER [ ] OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 2002 INT. HRS ______ EVA HRS 60 EVA CREW 2

   [ ] NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 90 DAYS SERVICES 35

   [ ] TMS/OTV REQUIRED ______ STATION HRS PER SERVICE 3

   [ ] NOT APPLICABLE ______ EVA HRS PER SERVICE 3

   EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   2.0 HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   [ ] NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL 180 DAYS TOTAL RECONFIGS. 19

   [ ] TMS/OTV REQUIRED STATION HRS PER RECONFIG. 2

   [ ] NOT APPLICABLE EVA HRS PER RECONFIG. 2

   EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

   DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

   [X] NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Station OPS - rescheduled beyond year 2000
3. Operate multidiscipline facility (e.g. target acquision, anamoly detection, etc.)
5. Payload operation continues beyond year 2000

TOTAL EVA HRS 203

Code: GDCD 0184

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Z-Continuous and Special Coverage

Reference Document:

1. Science and Applications Requirments Supplement, System Z, NASA Hq., 11 January 1983.

Narrative:

This payload element contains the full System Z instrument complement as shown in Table 0184-1. The complement is from Ref 1.

This is a multi-disciplinary payload that covers all areas of Earth resources, weather and climate and crustal motion. In the year 2002-2012 time frame it will replace the use of many individual free-flyers. Utilization of sensors is shown in Table 0184-2.

All instruments comprising this payload are developed and proven out on free-flyers during the 1990s decade.

This payload is configured as two integrated sets of instruments, similar to the configurations of the "Continuous Coverage" and "Special Coverage" free-flyer payload complements. The weight estimate is based upon the breakout given in Table 0184-3.

The two integrated instrument carriers can be delivered by multiple shuttle flights. EVA is required to assemble and checkout the payload, and for periodic servicing and updating.

Table 0184-1. System Z Instruments

INSTRUMENT	WT (kg)	POWER (kW)	DATA RATE (kbps)	CHARACTERISTICS	SPECIAL REQUIREMENTS
1. MODERATE FOV IMAGING RADIOMETER (MFIR)	100	0.1	30,000	50-12,000 m RES, 400-800 km SWATH WIDTH, 11 BANDS 0.4-12.5μm 100-500 nm RES	0.1 mrad POINTING STABILITY CYRO CRYO DET T
2. WIDE FOV IMAGING RADIOMETER (WRFF + 1 AVHRR+OCI) (WFIR)	50	0.05	10,000	300-600 m RES, 100-200 km SWATH 10-20 nm BANDS 0.4-0.6 8 VIS-TIR BANDS, 0.4-12.5 m, 200-1000 nm RES	0.6 mrad POINTING. STABILITY CRYO DET T
3. TM EQUIVALENT (TM)	250	0.35	85,000	30 m RES, 185 nm SWATH, 80 nm-1200 nm RES 7 BANDS, 0.4-12.5	0.020 mrad STABILITY CRYO DET T
4. RADAR ALTIMETER	150	0.2	10	1.2-12 km FOOTPRINT, NADIRLOOKING, 13 GH_z, 1 m ANT., MODIFIED FOR SIMULTANEOUS DPT MEAS	NONE
5. OCEAN WAVE DIRECTIONAL SPECTROMETER (OWDS)	100	0.1	1	14 GHz	1M CONICAL SCAN (10 CONE ANGLE)
6. SCANNING MULTIFRE-QUENCY MICRO-WAVE RADIO-METER (LAMMR)	300	0.5	200	6-50 GHz	4M CONICAL SCAN (60 CONE ANGLE)
7. RADAR SCATTEROMETER	150	0.2	10	13 GHz, 100 FOV	6 2M STICK ANTENNAS

Table 0184-1. System Z Instruments

8. IR/MICROWAVE	(SIZE 1.5x 3x 0.8M) 380	0.32	6.6	1 FOV 5 km IR, 25 km WAVE SCAN 45 28 IR CHANNELS 3.7-16.5 m 20 WAVE CHANNELS, 22-60 GHZ	AMTS + AMSU
9. MULTIFRE-QUENCY MICRO-WAVE LIMB SOUNDER (MLS)	100	0.4	10	10-200 GHz	LIMB POINTABLE
10. UV SPECTRO-METER LIMB SOUNDER	100	0.2	10	SIMILAR TO NIMBUS SBUV/TOMS	LIMB POINTABLE
11. CRYO IR GAS CORRELATION SPECTRO-RADIOMETER	300	0.5	200	2.5-25 COMBINATION OF GAS CORRELATION AND CRYO COOLED IR SPECTROMETERS	LIMB POINTABLE
12. DATA COLLEC-TION AND LOCATION SYSTEM (DCLS)	200	0.1	10	50 KHz B.W. at 400 MHz	4 10M BOOMS 120 FOV DISH
13. SOLAR MONI-TORING PACK-AGE					SUNWARD LOOKING
LOW RES SPECTROMETER	125	0.13	1	EUV AND UV	
BROADBAND RADIOMETER	20	0.01	0.17	VIS AND IR 0.4-50 m	
14. IMAGING SPEC-TROMETER (IS)	500	2	300,000	10M SPATIAL RES. 20 nm SPECTRAL, 0.4- 2.5 m, 10 km SWATH (240 BANDS)	2 POINTABLE WITH 0.01 mrad STABILITY CRYO DET T
15. HI RES IMAGING RADIOMETER (PHIR)	600	0.6	300,000	5 10M SPATIAL RES, 100 km SWATH, 24 BANDS BETWEEN 0.4-12.5 m 20 nm 20 nm SPECTRAL	2° POINTABLE WITH 0.1 mrad STABILITY CRYO DET T
16. THERMAL IR MULTISPECT, IMAGER (TIMS)	300	0.2	10,000	8-13, 100M SPATIAL RES, 50 km SWATH 200-500 nm	2° POINTABLE CRYO DET T
17. SCANNING LASER RANGER (LR + SLA)	500	10	300	0.5 3M VERT RES, 50 m HORIZONTAL	SCAN 45° CROSS-TRACK

Table 0184-1. System Z Instruments

18. MULTIFRE-QUENCY LIDAR FACILITY	2300	3-10	2000	0.3-13, 1.2M DIA TELESCOPE, 3M LONG	LASER CHANGE-OUT 45 CON-ICAL SCAN MIRROR
19. REAL APER-TURE RADAR FACILITY (GP-1)	1500	1	1000	6-35 GHz	10M CONICAL SCAN (0-80 CONE ANGLE) ANT., 30 rpm
20. PRECISION FAST SCAN-NING LARGE APERTURE MICROWAVE RADIOMETER/ SCATTEROMETER (PF)	1000	0.5	100	30-200 GHz	10 mrad POINT-ING ACCURACY 4M CONICAL SCAN (0-80 CONE ANGLE) 30 rpm
21. MULTIFRE-QUENCY, MULTIPOLARIZ, MULTILOOK ANGLE SAR (SAR)	800	5	300,000	25M RES, 100 km SWATH	2 x 15 m PLANAR ARRAY POINTABLE 0-60 CROSS TRACK (ONE SIDE)

INSTRUMENT CLASSES	ATMOSPHERIC CHEMISTRY	ATMOSPHERIC CIRCULATION	GLOBAL CLIMATE	OCEAN DYNAMICS – CIRCULATION	OCEAN DYNAMICS – SEA ICE	HYDROLOGY	BIOGEOCHEMICAL CYCLES	BIOMASS DYNAMICS	LAND COVER/ LAND USE DYNAMICS	CONTINENTAL GEOLOGY
VIS/IR MODERATE & WIDE FOV IMAGERS		X	X	X		X	X	X	X	X
VIS/IR HIGH RESOLUTION IMAGERS						X	X	X	X	X
LASER RANGERS/ALTIMETER					X			X	X	X
LIDAR FACILITY	X	X	X	X		X	X			X
PASSIVE CHEMICAL SPECIES SENSORS	X		X				X			
MICROWAVE RADIOMETERS		X	X	X	X	X	X			
IR & MICROWAVE SOUNDERS	X	X	X			X				
SCATTEROMETERS		X	X	X	X	X				
REAL APERTURE RADARS		X	X	X		X				
SYNTHETIC APERTURE RADARS					X	X		X	X	X
SOLAR SENSORS	X		X							
DATA COLLECTION LOCATION PLATFORM		X	X	X	X	X	X	X	X	X

266.592-421

Instrument Use Matrix

Table 0184-3

CONFIGURATION SIZING-ATTACHED MODE

POWER AND MASS ESTIMATE

SUBSYSTEM	CONTINUOUS MASS (kg)	CONTINUOUS POWER (kW)	SPECIAL MASS (kg)	SPECIAL POWER (kW)
TELECOM	0	0	0	0
POWER	25	0	174	0
COMMAND/DATA	150	0.75	150	0.75
DATA STORAGE	142	0.50	142	0.50
AACS	0	0	0	0
PROP (DRY)	0	0	0	0
STRUCTURE, CABLING, THERMAL CONTROL	950	0.50	2700	1.0
PAYLOAD	2325	3.16	7500	32.
TOTAL:	3,592	4.91	10,666	34.25
			3,592	4.91
		TOTAL:	14,258	39.16 (Use 40 kW)

NOTES:
(1) Provided by Space Station
(2) Power distribution at 5 kg/kW

Section 1.3

Discipline Environmental Observations

GDCD ID NO.	PAYLOAD ELEMENT NAME
	WEATHER/CLIMATE
0201	Satellite Doppler Meteorological Radar Technology Development
0202	Meteorology Instrument Group Development Payload
0203	Lightning Mapper
0204	Geosynchronous Microwave Sounder
0205	Meteorology Instrument Group Operations Payload
0206	Geostationary Operational Environmental Satellite (GOES) Follow-on
0207	TIROS Follow-on
	OCEAN
0221	Ocean Instrument Payload (OIP)
0222	Ocean Topography Experiment (TOPEX)
	SOLAR TERRESTRIAL
0241	Earth Radiation - Budget Experiment (ERBE)
0242	Incoherent Scatter Radar
0243	Topside Digital Ionosonde/HF Radar
0244	Solar Terrestrial Observatory - Advanced
0245	Space Plasma Physics Payload - Advanced
0246	Solar Terrestrial Observatory
0247	Space Plasma Physics Payload
	ATMOSPHERIC RESEARCH
0261	High Resolution Doppler Imager (HRDI)
0262	Measurement of Air Polution from Satellites (MAPS)
0263	CO_2 LIDAR for Atmospheric Trace Gas Concentration and Wind Velocity/ Transport Measurements
0264	LIDAR Facility
0265	Upper Atmosphere Research Payload-Development
0266	WINDSAT
0267	Upper Atmosphere Research Payload-Operational

PAYLOAD ELEMENT NAME
SAT DPLR Meteorolog Radar Tech

CODE GDCD0201

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Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1999
No. of flights 1
Duration of Flight, days 365

OBJECTIVE Develop enabling technology required for pushbroom doppler radar measurement of global rainfall rates and ocean surface wind vector associated with storm systems and other special meteorological features. Evaluate techniques using mm waves to provide 3-dimensional definition of nonprecipitating clouds.

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 3

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 9

DESCRIPTION

A multifrequency spaceborne meteorological radar will be assembled for in-orbit operations in a modular form so that different and/or additional receiver channels and antenna beams can be implemented as the experiment matures toward a proof-of-concept design for potential operational use. Measurements will be made of cloud thickness and height, rain rate, and wind velocity. The phased-array antenna will be assembled by EVA in a modularized form and attached to the space station for development testing and trial operations.

CODE G D C D 0 2 0 1

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 100 - 100
Inclination, deg 57 Tolerance + 33 - 28.5
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec 3600 Field of view, deg ±30 Nadir
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) Knowledge of Pointing ±6 arc sec

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	6000	
Standby	100	
Peak	6000	

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 120,000 Downlink Frequency (MHZ) ______

CODE GDCD0201

THERMAL

☒ Active ☐ Passive

Temperature, deg C operational min 10 max 25
non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 12.3 W,m 2.6 H,m 2.6 Stowed

L,m 50 W,m 5.2 H,m 5.2 Deployed

Launch mass, kg 2600

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 2 Task Assignment Select Instruments/Data Analysis

Skills (See Table B)

SKILL	4	5				
LEVEL	3	2				
Hrs/Day	0.2	0.2				

EVA ☒ YES ☐ NO Reason Assemble Antenna Hrs/EVA 24

SERVICING/MAINTENANCE

SERVICE: Interval, days 180 Consumables, kg ____

Returnables, kg ____ Man Hours 8

CONFIGURATION CHANGES: Interval, day 180 Man/Hrs Req. 8

Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Field and view ±30 degress Nadir cross range; ±3 degrees Nadir along track.

GDCD CODE 0201 ELEMENT NAME SATELLITE TOPPLER METEOROLOGICAL RADAR TECH.

ACCOMODATION: [X] ATTACHED [ ] FREE FLYER [ ] OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1999 INT. HRS ____ EVA HRS 16 EVA CREW 2

[ ] NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 180 DAYS TOTAL SERVICES 1

[ ] TMS/OTV REQUIRED ____ STATION HRS PER SERVICE 4

[ ] NOT APPLICABLE ____ EVA HRS PER SERVICE 4

EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.4 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

[ ] NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 180 DAYS TOTAL RECONFIGS. 1

[ ] TMS/OTV REQUIRED STATION HRS PER RECONFIG. 4

[ ] NOT APPLICABLE EVA HRS PER RECONFIG. 4

EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

DATE(S) 2000 INT. HRS. ____ EVA HRS ____ EVA CREW ____

[ ] NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Assemble large antenna
2. Assume resupply of cryogenics
3. 2 crew @ 0.2 hrs
4. Assume additional equipment
5. Station OPS

TOTAL EVA HRS 24

Code: GDCD 0201

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Satellite Doppler Meteoroligical Radar Technology Department

Reference Documents:

1. Space Station NAAO Study Orientation Meeting Handout at NASA Headquarters 14-15 September 1982
2. Space Platform Payload Data, Science and Application Space Platform Payload Accomodations Study, SP82-MSFC-2583, March 1982.

Narrative:

This payload element was listed as a candidate technology development mission on Page 50 of Attachment A to Ref 1. The mission utilized a large (50m) phased array antenna that is assembled by EVA in a modularized form. Different and/or additional receiver channels and antenna beams can be implemented as the experiment matures towards a Proof-of-Concept design for potential operational use. Attachment to a Space Station would allow ease of modification of antenna and other radar components as experiments progressed.

Physical characteristics for the payload element were derived from Ref 2, P C-4, "Synthetic Aperture Radar." The antenna size was scaled up from 12.3m to 50m and the system mass was scaled up from 800 kg to 2,600 kg. The SAR system operating power of 6 kW was used.

An orbit inclination of 28 1/2 degrees is satisfactory for development missions, but more useful operational data would be obtained at 57 degrees or higher.

Launch data and mission duration were derived by GDC.

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title: Earth Observations-
Instrument Development

Experiment Title: Satellite Doppler Meteorological Radar Technology Development

Mission Objectives: Develop enabling technology required for pushbroom Doppler radar measurement of global rainfall rates and ocean surface wind vector associated with storm systems and other meteorological features. Developmental techniques using millimeter waves will also be evaluated to provide three dimensional definition of non precipitating clouds.

Mission Description: A multifrequency spaceborne meteorological radar will be assembled for in-orbit operations in a modularized form so that different and/or additional receiver channels and antenna beams can be implemented as the experiment matures towards a Proof-of-Concept design for potential operational use.

Benefit: Measurement of cloud thickness and height, rain rates, and winds within cloudy environments not accessible to other regions of the spectrum and on a global scale would have enormous benefit to meteorology, crop predictions, flood predictions, and related activities.

Justification: Testing of the pushbroom Doppler radar and its ability to make geophysical measurements using a low developmental cost modularized Add-On approach would allow a final cost effective instrument to be realized and at the same time guarantee its usefulness in operational applications.

Mission Requirements and Capability: A relatively large (50m) phased array antenna would be assembled by EVA in a modularized form. Attachment to space station (at least in initial configurations) would allow ease of modification of antenna and other radar components as experiments progressed. Space station would house the modularized electronics, data handling equipment, and primary power.

Space Station vs. Free Flyer: Space Station

PAYLOAD ELEMENT NAME
Meteorology Inst Group Dev P1

CODE G D C D 0 2 0 2

TYPE
- [x] Science & Applications (non-commercial)
- [ ] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A) 3

CONTACT
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Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- [ ] Operational
- [ ] Approved
- [ ] Planned
- [x] Candidate
- [ ] Opportunity

First flight, yr 1993
No. of flights 1
Duration of Flight, days 365

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 6

OBJECTIVE

Measure vertical profiles of atmospheric temperature and pressure and surface pressure for input to numerical weather prediction models.

DESCRIPTION

This payload is an integrated set of meteorological measuring instruments with supporting structure and subsystem for power, signals and thermal control interfaces. The following instruments are included: Advanced Microwave Sounding Unit (AMSU); Advanced Moisture and Temperature Sounder (AMTS); and Microwave Pressure Sounder (MPS).

CODE G D C D 0 2 0 2

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 100 - 100
Inclination, deg 57 Tolerance + 33 - 28.5
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec 360 Field of view, deg ±50 crosstrack
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	1140	24
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) 1
Recording Rate (KBPS) 3000 Downlink Frequency (MHZ) ____

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CODE G D C D 0 2 0 2

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min 10 max 25
non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function. ☐ Pressurized ☒ Unpressurized

L,m 1.6 W,m 4.4 H,m 4.4 Stowed
L,m 1.6 W,m 4.4 H,m 4.4 Deployed

Launch mass, kg 1170

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 2 Task Assignment Monitor Data

Skills (See Table B)

SKILL	5	5				
LEVEL	2	2				
Hrs/Day	0.2	0.2				

EVA ☒ YES ☐ NO Reason Reconfig. Hrs/EVA 12

SERVICING/MAINTENANCE

SERVICE: Interval, days 90 Consumables, kg ____
Returnables, kg ____ Man Hours 4

CONFIGURATION CHANGES: Interval, day 90 Man/Hrs Req. 4
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

(1) Continuous operations required for global coverage at least twice daily.

(2) MPS radiates microwave RF energy.

(3) AMSU and MPS are sensitive to microwave RF interference at their operating frequencies. AMTS is sensitive to IR emission, absorption or scattering and to condensation on optics.

(4) AMTS requires orientation with respect to velocity vector.

GDCD CODE 0202 ELEMENT NAME METEOROLOGY INSTRUMENT GROUP DEVELOPMENT PAYLOAD

ACCOMODATION: [X] ATTACHED [ ] FREE FLYER [ ] OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1993 INT. HRS ______ EVA HRS ______ EVA CREW ______

[ ] NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 90 DAYS TOTAL SERVICES 3

[ ] TMS/OTV REQUIRED ______ STATION HRS PER SERVICE 2

[ ] NOT APPLICABLE ______ EVA HRS PER SERVICE 2

EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.4 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

[ ] NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 90 DAYS TOTAL RECONFIGS. 3

[ ] TMS/OTV REQUIRED STATION HRS PER RECONFIG. 2

[ ] NOT APPLICABLE EVA HRS PER RECONFIG. 2

EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

DATE(S) 1994 INT. HRS. ______ EVA HRS ______ EVA CREW ______

[ ] NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Station OPS
2. Assume resupply of cryogenics
3. 2 crew @ 0.2 hours each
4. Assume adjustments
5. station OPS

TOTAL EVA HRS 12

Code: GDCD 0202

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Meteorology Instrument Group Development Payload

Reference Documents:

1. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982.

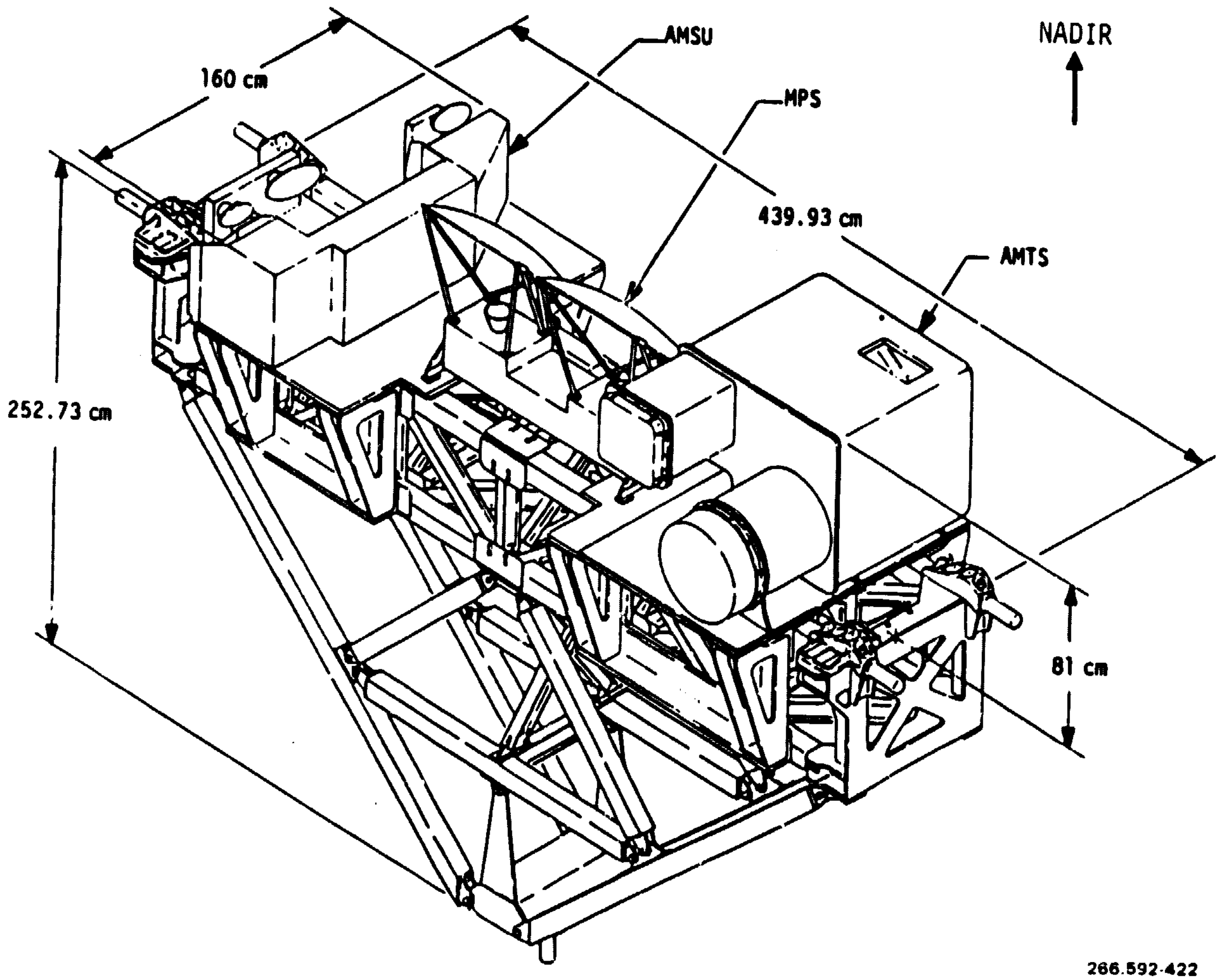
Narrative:

This group of instruments was originally defined for the MSFC SASP. The instrument selection, size, weight, and power are all taken directly from Ref 1, Page D-1.

For developmental missions, the instruments can benefit from the availability of man for real-time monitoring and control, adjustments, repair, updating, and servicing.

A similar payload is envisioned for later operational use in a high inclination orbit, either in a manned or unmanned mode.

Launch data and mission duration were derived by GDC.


160 cm
AMSU
MPS
NADIR
439.93 cm
AMTS
252.73 cm
81 cm
266.592-422

PAYLOAD ELEMENT NAME
Lighting Mapper

CODE
G D C D 0 2 0 3

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1998
No. of flights 1
Duration of Flight, days 1460

OBJECTIVE

Determine the role of lightning in the overall environmental system.

TYPE
- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 3

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 3

DESCRIPTION

Sensors (spacecraft) will be deployed at five geosynchronous locations to measure the location and strength of lightning flashes. A continuous viewing (day and night) is required.

CODE G D C D 0 2 0 3

ORBIT CHARACTERISTICS

Apogee, km 35,786 Perigee, km 35,786 Tolerance + ______ -
Inclination, deg 0 Tolerance + ______ -
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec 2 Field of view, deg 1 to 20
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	200	
Standby		
Peak		

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) 24 Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 2000 Downlink Frequency (MHZ) ______

CODE G D C D 0 2 0 3

THERMAL
☐ Active ☒ Passive
Temperature, deg C operational min ____ max ____
non-operational min ____ max ____
Heat Rejection, w operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS
Location: ☐ Internal ☐ External ☐ Remote
Equipment ID/Function ☐ Pressurized ☐ Unpressurized
L,m 6 W,m 2 H,m 3 Stowed
L,m 6 W,m 5 H,m 5 Deployed
Launch mass, kg 900
Consumables Types ____
Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS
Crew Size ____ Task Assignment ____
Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ____ Hrs/EVA ____

SERVICING/MAINTENANCE
SERVICE: Interval, days ____ Consumables, kg ____
Returnables, kg ____ Man Hours ____
CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Launch Only. There are 5 spacecraft, approximately equally spaced along the orbit. Each spacecraft weighs 900 kg.

GDCD CODE 0203 ELEMENT NAME LIGHTNING MAPPER

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1998 INT. HRS ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ______ DAYS TOTAL SERVICES ______

   ☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

   ☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

   EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ______ HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ______ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

5. Operations continue after year 2000

TOTAL EVA HRS 0

Code: GDCD 0203

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Lightning Mapper

Reference Documents:

1. Space Station NAAO Study Orientation Meeting Handout, NASA Headquarters 14 15 September 1982.

2. MSFC MEMO PS06 (97) W.T. Carey to R. Bowman, GDC re: Lightning Mapper, 19 September 1980.

Narrative:

This payload element was included as a proposed modest initiative in Ref 1 , P 8-20. Mission objectives and measurement requirements were listed in Ref 1, P 8-25.

The sensor system is a f/1.0 15cm aperture optical telescope with a low-light level TV detector. A pointing system is required that will yield an accuracy of 10 arc seconds and a stability of 1.0 arc second. Sensor system requirements were defined by Dr. Hugh Christian at the MSFC/SSL, and were transmitted to GDC with Ref (2).

This payload element description assumes that the sensor system is integrated with a small support spacecraft that provides attitude control, power, communications, and data handling, etc. (Wt. = 900 kg). AKM is not provided.

The spacecraft would by an OTV payload. Ideally, all five Lightning Mapper spacecraft would be emplaced by a single OTV flight.

Launch data and mission duration were derived by GDC.

EXAMPLE: LIGHTNING MAPPER

Measurements:	Location and strength of lightning flashes
Objectives:	Determine the role of lightning in the overall environmental system
Special Needs:	Continuous viewing, day and night sensitivity
Impacts:	Orbit
Solution:	Geosynchronous (5 Locations)

Reply to Attn of: PS06 (97)

September 19, 1980

Dr. Bob Bowman
General Dynamics/Convair Division
P. O. Box 80847
Mail Zone 21-9504
San Diego, CA 92138

SUBJECT: Lighning Mapper

As you know the Lightning Mapper Sensor System has been identified by NASA Headquarters OSTA as a candidate payload for the Experimental Geostationary Platform. The attached data sheet, developed by Dr. Hugh Christian of MSFC/SSL, describes the system as it is currently known. It was previously thought that the system would be comprised of both an RF and an optical system, however, the RF element has now been dropped. This was done because of the current belief that RF lightning emissions will be in wavelengths too long to penetrate the earths atmosphere to a measurable amount.

If further information on this system is needed please call me and we can set up a teleconference.

William T. Carey

William T. Carey
Chief, Applications Group

Info cc:
MTC-3/Mark Nolan
NASA Hq/Bill Bishop
ES81/Bill Vaughan
ES83/Hugh Christian
EC/Wayne Wagnon

CHARACTERISTICS OF STRAWMAN LIGHTNING MAPPER SENSOR SYSTEM

Telescope:

f/1.0
15 cm. aperture (5 km resolution)

Pointing:

Platform - Earth pointing with accuracy of $\pm 0.05°$
Sensor System -
Accuracy ± 10.0 sec (continuous)
Stability $\pm$ 1.0 sec (continuous)

Power:

150 watts

Weight:

Sensor - 60 kg
Pointing System - 80 kg

Volume:

2 m^3

Data Rate:

4.2 MHz Video
2 mb/s (continuous)

Temperature:

System - 0-40°C
Detector Control - TBD

Consumables:

TBD

Uplink for Hybrid r.f.-Optical System:

100 kb/s

These figures assume that the platform provides:

1) Power
2) Telemetry

Limited interruption of operation is tolerable; however, it will result in loss of real time and statistical data.

PAYLOAD ELEMENT NAME
Geosynchronous Microwave Sounder

CODE GDCD0204

CONTACT

Name: W. Hardy/J. Peterson MZ 21-9530

Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone: (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1999
No. of flights 1
Duration of Flight, days 1500

OBJECTIVE

All weather time variation of atmospheric temperature structure, mositure, and surface temperature

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 3

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 7

DESCRIPTION

A large antenna (33 m dia.) is used to measure microwave emissions of land, ocean, and atmosphere. Operating frequency image is 1 GHz to 150 GHz. Housekeeping functions can be provided by a MMS or Leasecraft type of bus. Transfer to GEO using a low thrust OTV.

CODE G D C 0 0 2 0 4

ORBIT CHARACTERISTICS

Apogee, km 35,786 Perigee, km 35,786 Tolerance + ____ -

Inclination, deg 0 Tolerance + ____ -

Nodal Angle, deg Variable Longitude Ephemeris Accuracy, m ____

Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth

Truth Sites (if known) ____

Pointing accuracy, arc sec 20 Field of view, deg ____

Pointing Stability (Jitter) arc sec/sec ____

Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	200 (Inst Only)	
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☐ Realtime ☐ Offline ☐ Other ____

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____

☐ On-Board Data Processing Required

Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____

Film (Amount) ____ Voice (Hrs/Day) ____

Live TV (Hrs/Day) ____ Other ____

On-Board Storage (MBIT) ____

Data Dump Frequency (Per Orbit) ____

Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 0 2 0 4

THERMAL
☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______
Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS
Location: ☐ Internal ☐ External ☐ Remote
Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 10	W,m 5	H,m 5	Stowed
L,m 40	W,m 60	H,m 33	Deployed

Launch mass, kg 5850
Consumables Types ______
Acceleration sensitivity, g min 0 max 0.2

CREW REQUIREMENTS
Crew Size ______ Task Assignment ______
Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☒ YES ☐ NO Reason Antenna Deploy Hrs/EVA 40

SERVICING/MAINTENANCE
SERVICE: Interval, days 800 Consumables, kg ______
Returnables, kg ______ Man Hours 16
CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Antenna diameter is 33m assembled and aligned in LEO.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0204 ELEMENT NAME GEOSYNCHRONOUS MICROWAVE SOUNDER

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1999 INT. HRS ____ EVA HRS 40 EVA CREW 1

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 800 DAYS TOTAL SERVICES 1

   ☒ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE 16

   ☐ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ____ HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Antenna deployment and alignment
2. Assume service in situ

5. Operation continues after year 2000

TOTAL EVA HRS 40

Code: GDCD 0204

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Geosynchronous Microwave Sounder

Reference Documents:

1. Space Station NAAO Study Orientation Meeting Handout NASA Headquarters, 14 - 15 September 1982.

2. MSFC Memo PS06(90), 28 August 1979. Re: Space Science Payloads for the Geostationary Platform.

3. JPL Report 710-12, pp 5-2 and 7-10

Narrative:

This payload element is listed as an example of an advanced meteorological remote sensor in Ref (1), Pg. 8-31.

The operational and physical characteristics of the sounder were taken from the description furnished by MSFC for the Geostationary Platform Study, Ref (2).

A 33 m diameter antenna suitable for operation up to 150 GHz was chosen. This requires a precision surface (E = 0.035 mm RMS). The antenna consists of 30 high-precision gore sections assembled and aligned at LEO. Antenna weight is estimated to be 3,000 kg, based on Ref (3).

The antenna and mission electronics are mounted on a standard support bus. A spacecraft weight statement is given in Table 0204-1.

The spacecraft is transfered from LEO to GEO by a low thrust OTV.

Launch data and mission duration were derived by GDC.

EXAMPLE: Geosynchronous Microwave Sounding

Measurement: Microwave emissions of land, ocean, and atmosphere

Objectives: All weather time variation of atmospheric temperature structure, moisture, and surface temperature

Special Needs: Large antenna (>25m diameter)

Impacts: Structure, orbit

Solution: Large spacecraft

Code: GDCD 0204

PAYLOAD ELEMENT SYNTHESIS

MICROWAVE SOUNDER

Objectives

1. General purpose receiving system for cm and mm wavelength emisions from the Earth and Sun.
2. Global mapping of atmospheric constituents such as precipitable water vapor.
3. Mapping of dispersion patterns of certain atmospheric pollutants with emission lines in the mm.
4. Measurements of ocean surface perturbations.
5. Measurements of solar emissions in wavelength bands unaccessible from within the atmosphere.

Requirements:

1. 33 m steerable parabolic antenna with surface smoothness of a few tenths of a mm.
2. Pointing: 20 arc seconds
3. Receives: 1 GHz to 150 GHz
4. Power: 200w (exclusive of pointing and steering)
5. Electronics Volume: 0.5 m^3 mounted with the antenna
   0.5 m^3 mounted seperately
6. Weight: 50 kg (exclusive of antenna)

Antenna (from JPL Report):

Transported to LEO in shuttle. Consists of 30 high-precision gore sections assembled and aligned to surface accy. of 0.035 mm rms. Graphite/epoxy structure. Weight: 3,000 kg.

TABLE 0204-1. Geosynch Microwave Sounder
Weight Statement

	Weight (lb)	
Structure	1,206	
Power	1,009	
Thermal	70	
Propulsion, drag	300	
TTC	100	
Attitude Control	420	
Mission Electronics	220	
Antenna, 33m	6,600	
Propellant	2,972	(2,823 useable)
	12,897 lb.	(5,850 kg)

$$\Delta V = Isp\ g\ \ln \frac{ws}{we} = 230 \times 32.2 \times \ln \frac{12,897}{10,074}$$

$$\Delta V = 1,830 \text{ fps}$$

Propellant supply is good for about seven years of operation at Δv = 260 fps per year. This allows about 55 fps per year for repositioning to different longitudes in addition to normal station keeping and momentum wheel unloading. Orbit transfer propulsion is not included.

PAYLOAD ELEMENT NAME
Meteorology Inst Group Oper P1

CODE
G D C D 0 2 0 5

CONTACT
Name
Address

W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1995
No. of flights 1
Duration of Flight, days 1200

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 3

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

OBJECTIVE

Measure vertical profiles of atmospheric temperature and pressure and surface pressure for input to numerical weather prediction models. (This payload is to be a man-tended operational version of the space station development payload GDCD 0202.)

DESCRIPTION

This payload is an integrated set of meteorological measuring instruments with supporting structure and subsystem for power signals and thermal control interfaces. The folloiwng instruments are included: Advanced Microwave Sounding Unit (AMSU). Advanced Moisture and Temperature Sounder (AMTS); and Microwave Pressure Sounder (MPS).

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CODE G D C D 0 2 0 5

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 100 - 100
Inclination, deg 57 Tolerance + 33 - 0
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec 360 Field of view, deg ±50 crosstrack
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	1140 (Instr)	24
Standby		
Peak		

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 3000 Downlink Frequency (MHZ) ______

CODE G D C D 0 2 0 5

THERMAL

☐ Active ☐ Passive

		min		max
Temperature, deg C	operational	10		25
	non-operational			
Heat Rejection, w	operational			
	non-operational			

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 1.6 W,m 4.4 H,m 4.4 Stowed

L,m 1.6 W,m 8 H,m 8 Deployed

Launch mass, kg 2000

Consumables Types

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days 700 Consumables, kg ______

Returnables, kg ______ Man Hours 4

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

(1) Continuous operations required for global coverage at least twice daily.
(2) MPS Radiates microwave RF energy
(3) AMSU & MPS are sensitive to microwave RF interference at their operating frequencies. AMTS is sensitive to IR emission, absorption or scattering and to condensation on optics.
(4) AMTS requires orientation with respect to velocity vector.

GDCD CODE 0205 ELEMENT NAME METEOROLOGY INSTRUMENTS GROUP OPERATIONS PAYLOAD

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1995 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 700 DAYS TOTAL SERVICES 1

   ☒ TMS/OTV ~~REQUIRED~~ ALTERNATE — STATION HRS PER SERVICE 4

   ☐ NOT APPLICABLE ____ — EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ____ HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED — STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE — EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) 1999 INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

This payload element assumes accommodation on a platform or Leasecraft type spacecraft which has orbit transfer propulsion.

2. Satellite service for propellant may be needed.

TOTAL EVA HRS 0

Code: GDCD 0205

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Meteorology Instrument Group Operations Payload

Reference Documents:

1. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982.

Narrative:

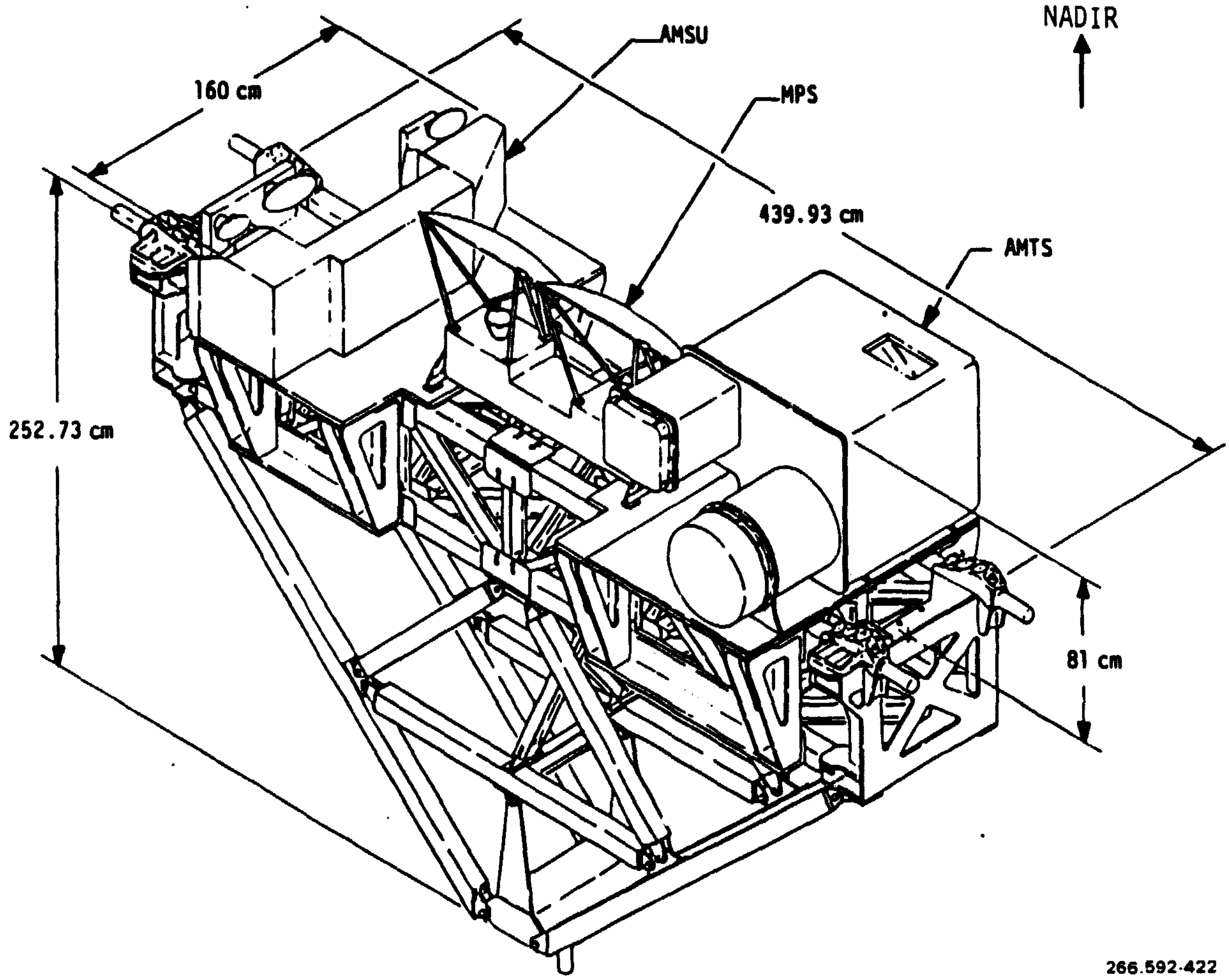
This group of instruments was originally defined for the MSFC SASP. The instrument selection, size, weight, and power are all taken directly from Ref (1) p D-1.

For operational missions, a high inclination (57-90 degrees) orbit is required. Periodic manned servicing and updating will be required. Operational control and monitoring may be via remote links. The weight is for the integrated instrument package only and would require orbit transfer propulsion and supporting services such as provided by Leasecraft-type spacecraft or platform accommodation.

(This is an operational version of the payload element described in GDCD 0202.)

Launch date and mission duration were derived by GDC.

This payload element assumes accommodation on a platform or Leasecraft-type spacecraft which has orbit transfer propulsion.


NADIR
AMSU
MPS
160 cm
439.93 cm
AMTS
252.73 cm
81 cm
266.592-422

PAYLOAD ELEMENT NAME
GOES Follow-On

CODE G D C D 0 2 U 6

TYPE
- [x] Science & Applications (non-commercial)
- [ ] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A) 3

CONTACT
Name
Address

W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- [ ] Operational
- [ ] Approved
- [ ] Planned
- [x] Candidate
- [ ] Opportunity

First flight, yr 1994
No. of flights 1
Duration of Flight, days >2200

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 3

OBJECTIVE

Meteorological measurements and data relay.

DESCRIPTION

Three satellites placed in different location in geostationary orbit. Geostationary Operational Environmental Satellite (GEOS) Follow-On

ORIGINAL PAGE IS
OF POOR QUALITY

CODE G D C D 0 2 0 6

ORBIT CHARACTERISTICS

Apogee, km 35,786 Perigee, km 35,786 Tolerance + -
Inclination, deg 0 Tolerance + -
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 28,000 Downlink Frequency (MHZ) S-Band

CODE G D C D 0 2 0 6

THERMAL
☐ Active ☐ Passive
Temperature, deg C operational min ______ max ______
non-operational min ______ max ______
Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS
Location: ☐ Internal ☐ External ☐ Remote
Equipment ID/Function ☐ Pressurized ☐ Unpressurized
L,m 3.6 W,m 2.2 H,m 2.2 Stowed
L,m 3.6 W,m 2.2 H,m 2.2 Deployed
Launch mass, kg 500
Consumables Types ______
Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS
Crew Size ______ Task Assignment ______
Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE
SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______
CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions
Launch Only. Three spacecraft in system; each weighs 500 kg on station (excludes AKM).

GDCD CODE 0206 ELEMENT NAME GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE (GOES) FOLLOW-ON

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1994 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ____ HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) 2000 INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

5. Considered as debris removal.

TOTAL EVA HRS 0

Code: GDCD 0206

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Geostationary Operational Environmental Satellite (GOES) Follow-On

Reference Documents:

1. "GOES Executive Summary," Hughes Aircraft Co., May 1978

Narrative:

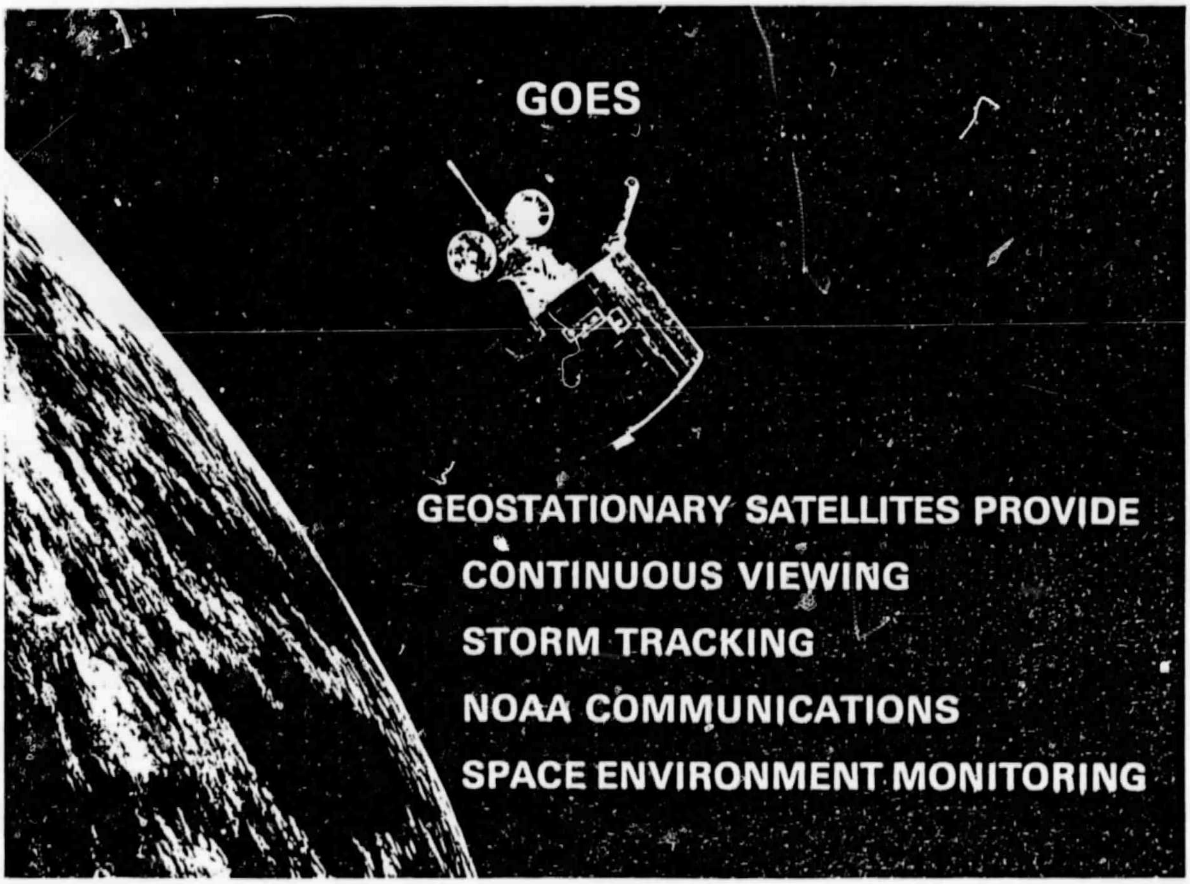
GOES is a component of the international World Weather Watch system. In this program, five geosynchronous orbit satellites supply continuous weather coverage of the Earth. Three GOES satellites operated by the U.S. are complemented by satellites operated by Europe and Japan.

The GOES Follow-on is an advanced version of GOES that could be launched from a space station OTV base. Remote servicing and repair in geosynchronous orbit are a potential role for a TMS that is transported by an OTV.

The physical characteristics are based upon those of the current GOES -D, -E and -F, excluding the apogee kick motor mass (Ref 1).

As an alternative accommodation mode, the meteorological instruments aboard GOES (Visible and IR spin scan radiometer atmospheric sounder, magnetometer, solar x-ray sensor, energetic particle detector, data relay system) could be installed on geostationary platforms.

Launch data and mission duration were derived by GDC.



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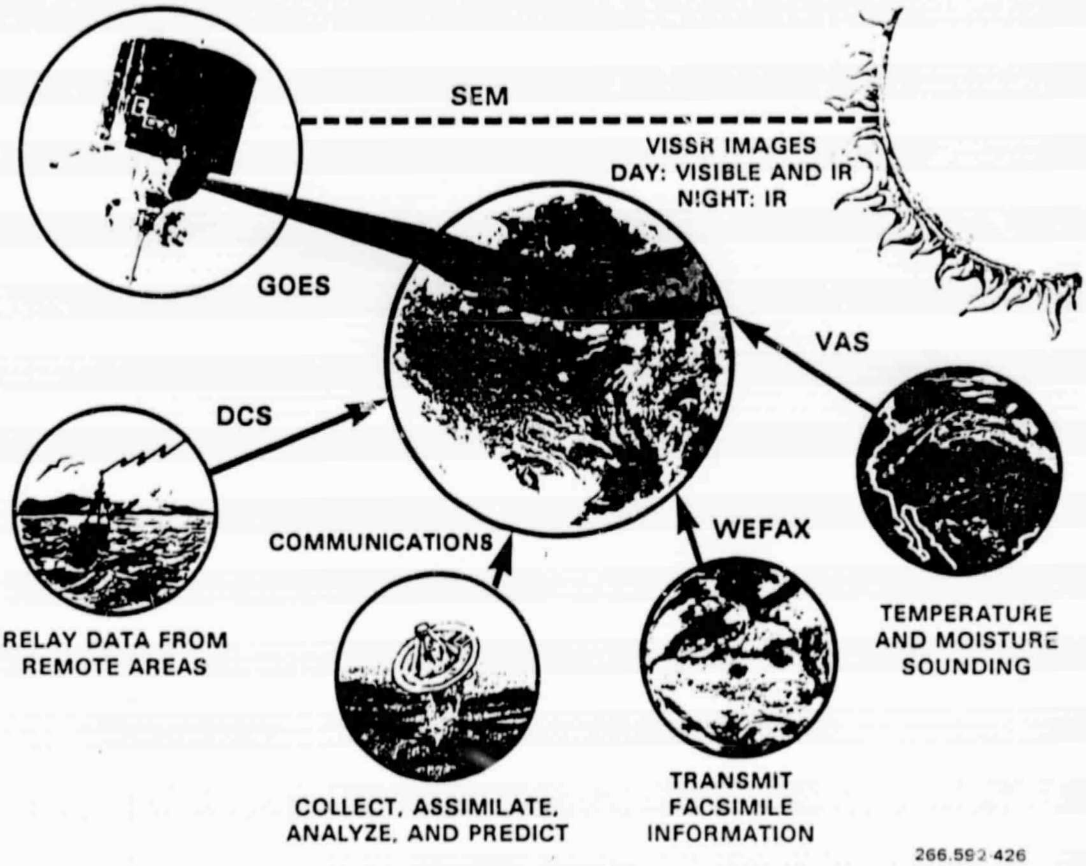
GOES



The Role of GOES

PAYLOAD ELEMENT NAME
TIROS Follow-On

CODE G D C D 0 2 0 7

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
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Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1992
No. of flights 1
Duration of Flight, days >2900

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 3

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 3

OBJECTIVE

Meteorological measurements and data relay.

DESCRIPTION

Satellite in Sun synchronous orbit.

CODE GDCD0207

ORBIT CHARACTERISTICS

Apogee, km 800 Perigee, km 800 Tolerance + ______ - ______
Inclination, deg 98 Tolerance + ______ - ______
Nodal Angle, deg (Sun synch) Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec ______ Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

CODE GDCD0207

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☒ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 9 W,m 4 H,m 4 Stowed

L,m 15 W,m 12 H,m 4 Deployed

Launch mass, kg 2000

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size ______

Task Assignment

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GOCD CODE 0207 ELEMENT NAME TIROS FOLLOW-ON

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1992 INT. HRS ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ______ DAYS TOTAL SERVICES ______

   ☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

   ☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

   EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ______ HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ______ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

5. Payload operation continues after year 2000.

TOTAL EVA HRS 0

Code: GDCD 0207

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: TIROS Follow-On

Reference Documents:

1. Space Station NAAO Study, 14 & 15 September 1982 Orientation Meeting handout at NASA Headquarters

Narrative:

The TIROS/NOAA multi-mission sensing satellites provide daily (day and night) observations of the global weather. They collect data on atmosphereic temperature and humidity profiles, cloud coverage profiles, solar particles, ocean currents and temperatures, sea ice, and atmospheric/stratospheric conditions. Also, the NOAA series collects data from remote fixed or moving sensing platforms. Advanced satellites will also provide search-and-rescue (SAR) functions for ships and aircraft, ozone mapping of the atmosphere, and measurement of the incoming and outgoing planetary thermal radiation. Instrument complements (Ref 1) are listed on p 2 and indentified on p 3.

These satellites require near polar, sun-synchronous orbits. At least two must operate simultaneously.

These spacecraft will be shuttle launched into LEO. Self-contained propulsion systems are employed for orbit adjustments. An orbit transfer propulsion system is not included.

Launch date and mission duration were derived.

Code: GDCD 0207

PAYLOAD ELEMENT SYNTHESIS

	LAUNCH DATE	AVHRR	HIRS-2	MSU	SSU	DCS	SBUV	ERBE	SEM	SAR
TIROS-N	10/78	●	●	●	○	●			●	
NOAA-A	6/79	●	●	●	○	●			●	
NOAA-C	6/81	●	●	●	○	●			●	
NOAA-D	10/81	●	●	●	☆	●			☆	
NOAA-E	5/83	●	●	●	○	●			●	●
NOAA-F	10/83	●	●	●	☆	●	○	○	*	●
NOAA-G	5/85	●	●	●	○	●	○	○	●	●
NOAA-H	10/85	●	●	●	☆	●	○	☆	☆	
NOAA-I	5/87	●	●	●	○	●	○	☆	●	
NOAA-J	10/87	●	●	●	☆	●	○	☆	☆	

☆ SPACE, WT, POWER UNASSIGNED

* POSSIBLE DOE NUCLEAR TESTING DEVELOPMENT DETECTOR IN PLACE OF SEM ON NOAA-F

266.592-427

NOAA Satellites Instrument Plan

Code: GDCD 0207

PAYLOAD ELEMENT SYNTHESIS

NOAA Satellites Instruments
(TIROS-N)

1. AVHRR - Advanced Very High Resolution Radiometer
(Visible/IR with Field of View Imaging Radiometer)

2. HIRS-2 - High Resolution Infra Red Sounder

3. MSU - Microwave Sounding Unit

4. SSU - Stratospheric Sounding Unit

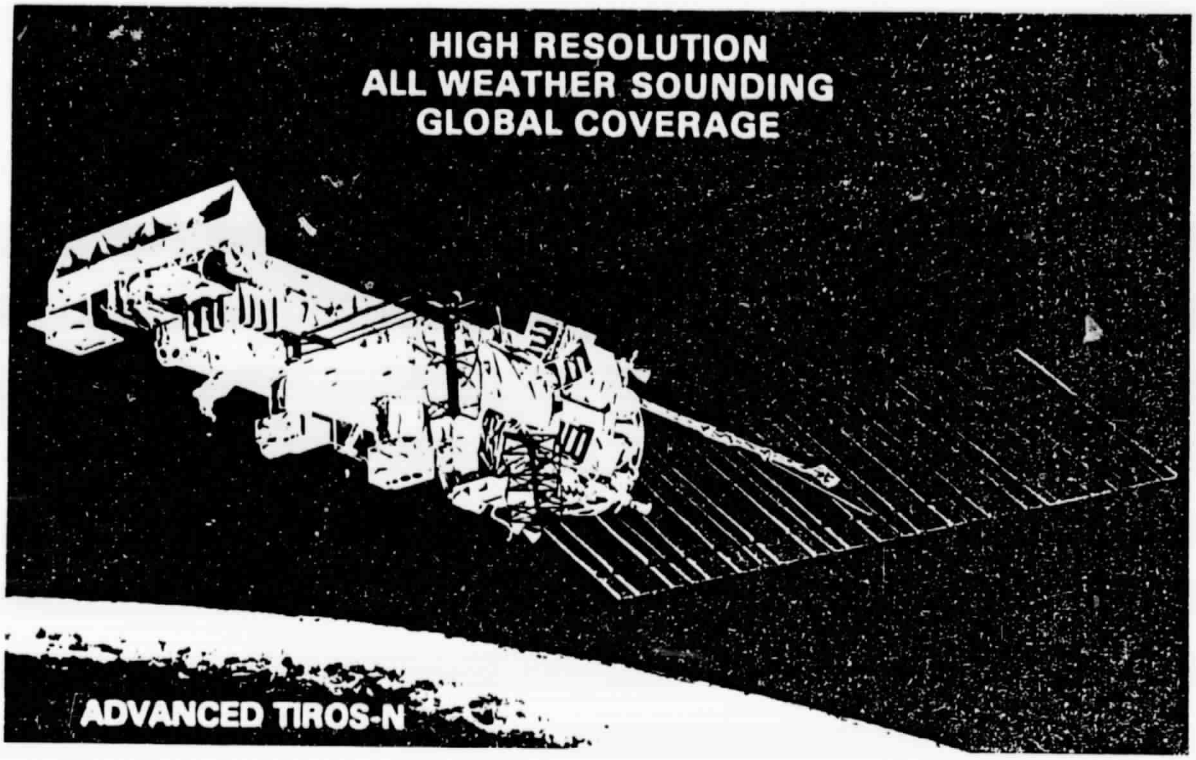
5. DCS - Data Collection System

6. SBUV - Solar Backscatter Ultraviolet

7. ERBE - Earth Radiation Budget Experiment Scanner
(Wide/Medium Field of View)

8. SEM - Space Environment Monitor

9. SAR - Search and Rescue



266.592-428

Low Earth Polar Orbiters Provide

As an alternative to the integrated spacecraft concept shown on page 4, the sensors could be accommodated or an instrument platform which is supported by a Leasecraft-type bus.

This would increase the mass to around 7000-8000 kg but would provide for much greater ΔV for orbit adjustments and for on-orbit servicing by the shuttle or TMS/space station.

PAYLOAD ELEMENT NAME
Ocean Instrument Payload (OIP)

CODE
G D C D 0 2 2 1

TYPE
☒ Science & Applications (non-commercial)
☐ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 3

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 1994
No. of flights 2
Duration of Flight, days 1825

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 9

OBJECTIVE

To quantify patterns and variability of phytoplankton chlorophyll on a global scale develop and deploy sensors for detection of night bioluminescence and chlorophyll fluorescence, and gain insight into spatial organization of marine systems by an astute observer knowledgeable in ocean and plankton dynamics.

DESCRIPTION

The Ocean Instrument Payload (OIP) typically contains the scatterometer, ocean color imager, passive microwave radiometer and synthetic aperture radar, for deployment and operation. Also it contains the ocean microwave package (multibeam altimeter antenna and directional wave spectrometer) typical for check-out and evaluation for new ocean instrument techniques. Equipment could be externally mounted with a services interface to internal sources.

CODE G D C D 0 2 2 1

ORBIT CHARACTERISTICS

Apogee, km 500 Perigee, km 500 Tolerance + 300 - 200
Inclination, deg 98 Tolerance + 0 - 41
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) Laser
Pointing accuracy, arc sec 1080 Field of view, deg ±45 Nadir
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	1200	18
Standby	120	
Peak		

☐ Continuous

Voltage, V 28 Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) 1,000,000
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 110,200 Downlink Frequency (MHZ) ______

CODE G D C D 0 2 2 1 — Page 3 of 3

THERMAL

☐ Active ☒ Passive

Temperature, deg C — operational min 10 max 35
non-operational min -20 max 40

Heat Rejection, w — operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

	L,m	W,m	H,m	
	10	4	2.5	Stowed
	16	10	2.5	Deployed

Launch mass, kg 1600

Consumables Types ____

Acceleration sensitivity, g min 0 max 0.2

CREW REQUIREMENTS

Crew Size ____ Task Assignment ____

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ____ Hrs/EVA ____

SERVICING/MAINTENANCE

SERVICE: Interval, days 730 Consumables, kg ____
Returnables, kg ____ Man Hours 16

CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Operate continuously over oceans, 70% of orbit for the color imager, orbit is to be Sun synchronous with hour angle between 10:AM and 2:PM. This payload is a combination of the ocean color imager (OCI) and the wind scatterometer (SCATT). Potential interference between the instrument must be carefully considered in payload design. Second launch is in 1999.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0221 ELEMENT NAME OCEAN INSTRUMENT PAYLOAD (OIP)

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1994 INT. HRS ____ EVA HRS ____ EVA CREW ____

1999

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 730 DAYS TOTAL SERVICES 2

☒ TMS/OTV ~~REQUIRED~~ ALTERNATE STATION HRS PER SERVICE 16

☐ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

____ HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☒ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) 1999 INT. HRS. ____ EVA HRS ____ EVA CREW ____

2nd payload continues after 2000

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

This payload element assumes accommodation on a platform or Leasecraft type spacecraft which has orbit transfer propulsion.

2. Satellite service for propellant may be needed.

TOTAL EVA HRS 0

Code: GDCD 0221

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Ocean Instrument Payload (OIP)

Reference Documents:

1. Space Station NAAO Study Orientation Meeting Handout, NASA Headquarters, 14-15 September 1982

2. Science and Applications Requirements for Space Station, Draft, Provided 17 November 1982 at Interim Review at NASA Hq.

Narrative:

This payload was conceived to be two separate items - Ocean Color Imager (OCI) and Wind Scatterometer (SCATT) - as suggested in Ref (1). However, it seemed that the two might be combined into one payload as GDCD 0221 for study of the ocean surface characteristics. Other instruments were added to expand the instrument package. The sun synchronous orbit was chosen to accommodate the color imager, (Ref 1), pp 8-14, 8-17, and 8-28.

Data for the instruments and their requirements were obtained from Ref (2), paragraph 3.1.2.4.

The variety of instruments will drive the payload design as to potential mutual interference. The weight includes only the instrument package and would require a platform or Leasecraft-type bus to provide orbit transfer propulsion and support resources.

PAYLOAD ELEMENT NAME
Ocean Topography Exp (TOPEX)

CODE G D C D 0 2 2 2

TYPE
☒ Science & Applications (non-commercial)
☐ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 3

CONTACT
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STATUS
☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 1988
No. of flights 1
Duration of Flight, days 3650

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 6

OBJECTIVE

The ocean topography experiment (TOPEX) is to determine the general circulation (or current structure) of the global oceans. It is to advance the understanding of global ocean circulation, and provide an understanding of its wind driven component.

DESCRIPTION

The TOPEX is a free-flyer containing instruments such as: radar altimeter with 2-cm precision measurement of ocean current structure, accelerometer for orbit determination to 10-cm accuracy laser retroflector, gravity, gradiometer, and 6-stick KU-band wind scatterometer (SCATT) While the TOPEX satellite may predate the sapce station, the space station could be used for on-orbit servicing thus extending the useful life of TOPEX by several years.

CODE G D C D 0 2 2 2

ORBIT CHARACTERISTICS

Apogee, km 1384 Perigee, km 1384 Tolerance + 5 - 5
Inclination, deg 63.4 Tolerance + 0.2 - 0.2
Nodal Angle, deg ____ Ephemeris Accuracy, m ±0.1
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) Laser
Pointing accuracy, arc sec 1440 Field of view, deg ±45 Nadir
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	600	18
Standby	50	
Peak		

☐ Continuous

Voltage, V 28 Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☒ Uplink Req.: Command Rate (KBS) 20 Frequency (MHZ) ____
☒ On-Board Data Processing Required
Description
Subsystem Monitor During Servicing

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) 3000
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 15 Downlink Frequency (MHZ) ____

CODE G D C D 0 2 2 2

THERMAL

☐ Active ☒ Passive

		min	max
Temperature, deg C	operational	10	35
	non-operational	-20	40
Heat Rejection, w	operational		
	non-operational		

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☒ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

	L,m	W,m	H,m
Stowed	6	2.5	2.5
Deployed	6	5	5

Launch mass, kg 1600

Consumables Types Attitude Control

Acceleration sensitivity, g min 0 max 0.2

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days 1000 Consumables, kg 100

Returnables, kg 20 Man Hours 16

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Unique orbit, precisely repeating ground track every 10 days spacecraft will be orbited prior to space station, the space station will service only.

GOCO CODE 0222 ELEMENT NAME OCEAN TOPOGRAPHY EXPERIMENT (TOPEX)

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1988 INT. HRS ______ EVA HRS ______ EVA CREW ______

   ☒ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 1000 DAYS TOTAL SERVICES 3

   ☒ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE 16

   ☐ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

   EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ______ HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ______ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) 1998 INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Initially launched in 1988.
2. Replacement of attitude control and propellants assumed.

TOTAL EVA HRS 0

Code: GDCD 0222

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Ocean Topography Experiment (TOPEX)

Reference Documents:

1. Space Station NAAO Study, 14 15 September 1892 Orientation Meeting Handout at NASA Headquarters.

2. Science and Applications Requirements for Space Station, Draft, Provided 17 November 1982 at Interim Review at NASA Hq.

Narrative:

The payload objective is to determine the general structure of ocean circulation currents.

The orbit is unique: 1384 kilometers altitude, 63.4 deg inclination creating a 10-day cycle repeating ground track.

The payload will be launched prior to Space Station /TMS ERA (1990). The first Space Station-to-payload interface will be the servicing of the spacecraft, which does not contain orbit transfer propulsion.

The data were obtained from Ref (1), p 8-16, 8-24 and from Ref (2), paragraph 3.1.2.4.

PAYLOAD ELEMENT NAME
Earth Radiation Budget Exp

CODE G D C D 0 2 4 1

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1991
No. of flights 2
Duration of Flight, days 365

OBJECTIVE
To measure the amount and spectrum of thermal radiation from the Earth into space over a broad wavelength spectrum

TYPE
- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 3

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 5

DESCRIPTION Sensors for the Earth Radiation Budget Experiment (ERBE) are contained in two instrument packages, a wide and medium field of view (W/MFOV) unit and a scanner unit. The scanner unit contains three boresighted sensors (3° FOV), mounts facing Earth nadir, and scans the sensors cross-track from horizon to horizon.
The W/MFOV unit contains two nadir pointing sensors (FOV -130°) viewing the entire Earth disk, two nadir pointing sensors (FOV -75°) viewing a 10° Earth central angle, and a solar viewing cavity radiometer. This unit contains its own azimuth pointing gimbal.
Later to become part of solar terrestrial observatory.

CODE
GDCD0241

ORBIT CHARACTERISTICS

Apogee, km 600/800 Perigee, km 600/800 Tolerance + ____ - ____
Inclination, deg 46/98 Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☒ Solar ☒ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	60	24
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 1.04 Downlink Frequency (MHZ) ____

CODE G D C D 0 2 4 1

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min 10 max 35
non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 1 W,m 1 H,m 1 Stowed
L,m 1 W,m 1 H,m 1 Deployed

Launch mass, kg 55

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size ____ Task Assignment Observe Data

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ____ Hrs/EVA ____

SERVICING/MAINTENANCE

SERVICE: Interval, days ____ Consumables, kg ____
Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Two spacecraft are required, one in each orbit 600 km at 46 deg. and 80 km at 98 deg.

Emissions/Susceptibilities: ERBE scanner measurement channels are 0.2-5 μm, 5-50 μm, and 0.2-50 μm. The ERBE scanner would be sensitive to contaminants effective within these spectral ranges.

ERBE W/MFOV measurement channels are 0.2-5 μm and 0.2-50+ μm, ERBE W/MFOV would be sensitive to contaminants effective within these spectral ranges.

Operational Requirements: Duty cycle of ERBE W/MFOV unit, continuous operation is anticipated. Data is averaged on a monthly basis. Monthly sampling of the solar flux density is desired. Earth viewing sensors (wire-bound thermopiles) view internally during launch and outgassing and view the sun, space and internal black-body sources for periodic in-flight calibration.

GDCD CODE 0241 ELEMENT NAME EARTH RADIATION BUDGET EXPERIMENT

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1991 INT. HRS ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ______ DAYS TOTAL SERVICES ______

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

______ HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☒ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) 1992 INT. HRS. ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

This payload element assumes accommodation on a platform or Leasecraft type spacecraft which has orbit transfer propulsion.

1. Two payloads ride piggyback on other P/L (2 different inclinations)

TOTAL EVA HRS 0

Code: GDCD 0241

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Eartn Radiation Budget Experiment (ERBE)

Reference Documents:

1. Space Station NAAO Study Orientation Meeting Handout, NASA Headquarters, 14-15 September 1982
2. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Stuay, SP82-MSFC-2583, March 1982.

Narrative:

This payload element was listed as an approved mission in development in Ref (1) p 8-20.

The instruments are required to be displayed on multiple spacecraft in different orbits to obtain a large number of observations uniformly in space and time.

The first instrument set will be launched aboard the Earth Radiation Budget Satellite (ERBS) in 1984. It will be shuttle launched (STS-17) into LEO. An orbit adjust propulsion system will raise the satellite into a 600 km, 46 deg inclined circular orbit.

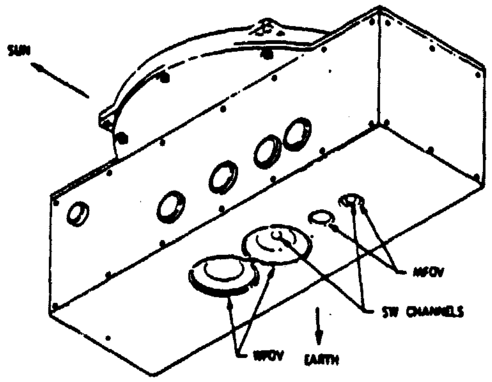
Additional instrument sets will be launched in 1983 and 1985 aboard NOAA satellites.

In the 1990s, advanced instruments will be developed and will be employed on manned or unmanned platforms at high inclination. (46 deg and 98 deg).

Physical descriptions were taken from Ref 2, pp D-80 and -81. This payload element assumes accommodation on a platform or Leasecraft-type spacecraft which has orbit transfer propulsion.

Launch date and mission duration were derived.

Code: GDCD 0241 PAYLOAD ELEMENT SYNTHESIS



DESCRIPTION

MASS UP/DOWN (kg): 30/30
SIZE (m): 0.67 x 0.25 x 0.24
POWER OP./PK.(kW): 0.017/TBD
HEAT REJECTION: Passive
DATA SCI./STAT.(kbps): 0.240 Total
POINTING TYPE: Earth nadir, solar
ACC.( )/STAB.( ): TBD
OPERATING COND: Continuous
ORBIT (km/deg): 600/46 or SS polar
FLIGHT DURATION (mo.): TBD

DESCRIPTION: Sensors for the Earth Radiation Budget Experiment (ERBE) are contained in two instrument packages, a Wide and Medium Field of View (W/MFOV) unit and a Scanner unit. The W/MFOV unit contains two nadir pointing sensors (FOV ~130°) viewing the entire Earth disk, two nadir pointing sensors (FOV ~75°) viewing a 10° Earth central angle, and a solar viewing cavity radiometer. This unit contains its own azimuth pointing gimbal.

EMISSIONS/SUSCEPTIBILITIES: ERBE W/MFOV measurement channels are 0.2-5 μm and 0.2-50+ μm. ERBE W/MFOV would be sensitive to contaminants effective within these spectral ranges.

OPERATIONAL REQUIREMENTS: Duty cycle of ERBE W/MFOV unit was not specified but continuous operation is anticipated. Data is averaged on a monthly basis. Monthly sampling of the solar flux density is desired. Earth viewing sensors (wire-wound thermopiles) view internally during launch and outgassing and view the sun, space and internal black-body sources for periodic in-flight calibration.

SPECIAL CONSIDERATIONS: ERBE objectives require simultaneous sampling of the radiation reflected from and emitted by Earth. A minimum of two flight vehicles are needed, one in a 46°, 600 km orbit and the other in a high inclination orbit (polar mid-morning or mid-afternoon preferred).

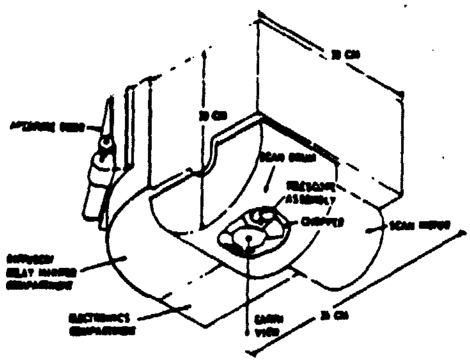
CONTACT: D. Miller, NASA Headquarters

REFERENCE: Handbook of Sensor Technical Characteristics, compiled for NASA OSTA by Systematics General Corp., September 1981.

ORIGINAL PAGE IS
OF POOR QUALITY

Code: GDCD 0241

PAYLOAD ELEMENT SYNTHESIS



DESCRIPTION

MASS UP/DOWN (kg): 25/25
SIZE (m): 0.36 x 0.33 x 0.30
POWER OP./PK.(kW): 0.035/TBD
HEAT REJECTION: Passive
DATA SCI./STAT.(kbps): 0.880 Total
POINTING TYPE: Earth nadir, solar
ACC.( )/STAB.( ): TBD
OPERATING COND: Continuous
ORBIT (km/deg): 600/46 or SS polar
FLIGHT DURATION (mo.): TBD

DESCRIPTION: Sensors for the Earth Radiation Budget Experiment (ERBE) are contained in two instrument packages, a Wide and Medium Field of View (W/MFOV) unit and a Scanner unit. The Scanner unit contains three boresighted sensors (3° FOV), mounts facing Earth nadir, and scans the sensors cross-track from horizon to horizon.

EMISSIONS/SUSCEPTIBILITIES: ERBE Scanner measurement channels are 0.2-5 µm, 5-50 µm, and 0.2-50 µm. The ERBE Scanner would be sensitive to contaminants effective within these spectral ranges.

OPERATIONAL REQUIREMENTS: The duty cycle of the ERBE Scanner unit was not specified but continuous operation is anticipated. Data is averaged on a monthly basis. The continuously rotating scan drum sequences each sensor (pyroelectric type) through the Earth scan, a deep space view, and either a black-body view (long wave and total bands) or a sun view (short wave and total bands).

SPECIAL CONSIDERATIONS: ERBE objectives require simultaneous sampling of the radiation reflected from and emitted by Earth. A minimum of two flight vehicles are needed, one in a 46°, 600 km orbit and the other in a high inclination orbit (polar mid-morning or mid-afternoon preferred).

CONTACT: D. Diller, NASA Headquarters

REFERENCE: Handbook of Sensor Technical Characteristics, compiled for NASA OSTA by Systematics General Corp., September 1981.

Earth Radiation Budget Experiment (contd)

PAYLOAD ELEMENT NAME
Incoherent Scatter Radar

CODE G D C D 0 2 4 2

CONTACT

Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1996
No. of flights 2
Duration of Flight, days 365

OBJECTIVE

To develop and operate from near-Earth space a UHF incoherent scatter radar for remote-sensing of Earth's upper atmosphere to determine its ambient behavior, and provide specific diagnostic support to active plasma physics experiment.

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 3

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 6

DESCRIPTION

Transmitter, receiver and computer are contained within the space station. The large antenna dish (25m when deployed) will operate in the UHF region of 300 - 3000 MHz band.

CODE G D C D 0 2 4 2

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 100 - 0
Inclination, deg 28.5 and 90 Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth and Sky Viewing
Truth Sites (if known) ____
Pointing accuracy, arc sec 18,000 Field of view, deg ±45 Nadir
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	1500	
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE GDCD0242

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min 10 max 35

non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____

non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☒ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 4 W,m 2 H,m 1 Stowed

L,m 25 W,m 25 H,m 15 (Ant) Deployed

Launch mass, kg 1000

Consumables Types ____

Acceleration sensitivity, g min 0 max 0.2

CREW REQUIREMENTS

Crew Size 1 Task Assignment Monitor/Operate Equipment

Skills (See Table B)

SKILL	5					
LEVEL	2					
Hrs/Day	0.5					

EVA ☒ YES ☐ NO Reason Assy/Disassy Ant Hrs/EVA 16

SERVICING/MAINTENANCE

SERVICE: Interval, days ____ Consumables, kg ____

Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____

Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Susceptible to RF noise background. Power capacity bank, head disipation and antenna size requirements as well as frequent man-machine interfacing. Two missions are desired, one at an inclination of zero degrees (28.5 acceptable) and one at 90 degree polar orbit. Second flight is in 1998.

GDCD CODE 0242 ELEMENT NAME INCOHERENT SCATTER RADAR

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S)	INT. HRS	EVA HRS	EVA CREW
1996	4	4	1
1998	4	4	1

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL _____ DAYS TOTAL SERVICES _____

☐ TMS/OTV REQUIRED _____ STATION HRS PER SERVICE _____

☒ NOT APPLICABLE _____ EVA HRS PER SERVICE _____

EVA CREW SIZE _____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.5 HRS PER DAY (INTERNAL)

_____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL _____ DAYS TOTAL RECONFIGS. _____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. _____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. _____

EVA CREW SIZE _____

5. DEACTIVATION/REMOVAL

DATE(S)	INT. HRS.	EVA HRS	EVA CREW
1997	4	4	1
1999	4	4	1

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Antenna Assembly plus station OPS
3. Monitor/operate equipment
5. Antenna removal plus station OPS

TOTAL EVA HRS 16

Code: GDCD 0242

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Incoherent Scatter Radar

Reference Document:

1. Space Station Missions Upper Atmospheric Research, Lewis M. Duncan, ESS-7, MS466 Los Alamos Nat. Lab., Received September 30, 1982.

2. L.M. Duncan, Telecon, February 18, 1982.

Narrative:

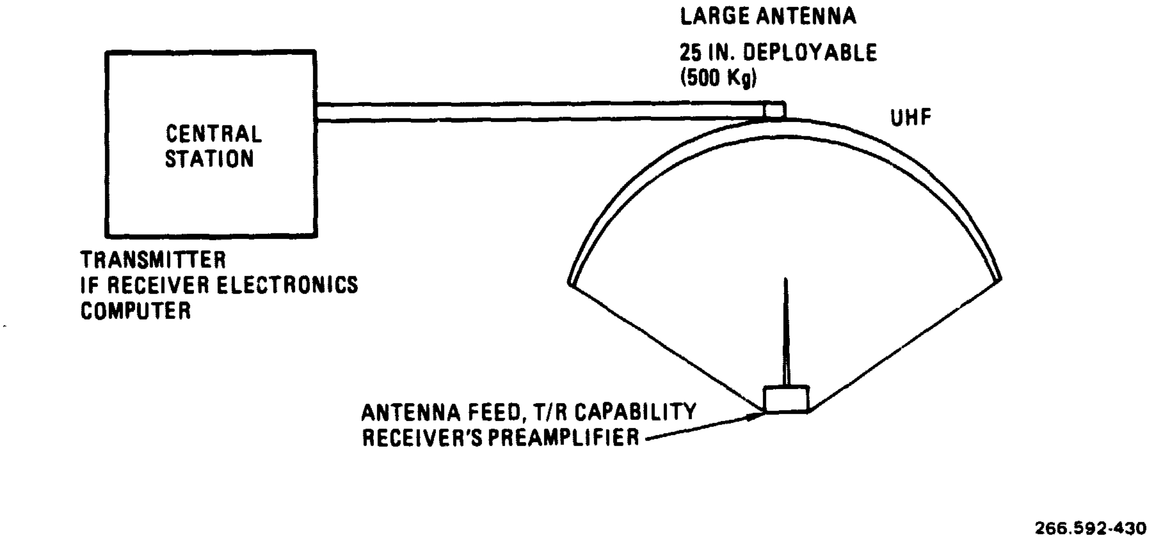
This mission was suggested by Dr. Lewis M. Duncan of Los Alamos National Laboratory (Ref 1).

The physical characteristics of the payload element were derived, based on similarity to other UHF radar equipment, and assuming a 25m diameter deployable antenna such as the deployable truss type.

This payload element has applications in several scientific disciplines; i.e., Atmospheric Physics and Plasma Physics.

Launch date and mission duration were derived.

Crew time was averaged, over the life of the experment based on four hours per week per Ref (2).



Incoherent Scatter Radar

INSTRUMENT :

INCOHERENT SCATTER RADAR

APPLICATIONS :

BASIC STUDIES OF UPPER ATMOSPHERE (AERONOMY)

SOLAR - TERRESTRIAL RELATIONS

IONOSPHERE - MAGNETOSPHERE COUPLING

ACTIVE EXPERIMENTS IN SPACE PLASMAS

- HF IONOSPHERIC MODIFICATION
- CHEMICAL RELEASES
- WAVE INJECTION
- BEAM-PLASMA INTERACTIONS

266.592-431

Incoherent Scatter Radar (contd)

WHAT DOES AN INCOHERENT SCATTER RADAR DO?

HIGH SPATIAL- AND TEMPORAL-
RESOLUTION MEASUREMENTS OF:

ELECTRON DENSITY

ELECTRON & ION TEMPERATURES

IONOSPHERIC WINDS AND DRIFTS

ION COMPOSITION

PLASMA WAVE TURBULENCE

266.592-432

JUSTIFICATION :

LONG-DURATION, GLOBAL COVERAGE MISSIONS

LARGE POWER, CAPACITOR BANK, HEAT
DISSIPATION REQUIREMENTS

LARGE ANTENNA WITH POINTING REQUIREMENTS

ANTICIPATED MAN-MACHINE INTERFACING NEEDS

266.592-433

Incoherent Scatter Radar (contd)

INCOHERENT SCATTER RADAR

I. Mission Objectives

To develop and operate from near-earth space a UHF incoherent scatter radar for remote-sensing of the earth's upper atmosphere.

II. Mission Description

The proposed mission will provide worldwide observations of upper atmospheric morphology and dynamics through the monitoring of ionospheric electron densities, electron and ion temperatures, ionospheric drifts and background winds, ion composition, and plasma wave turbulence. Incoherent scatter radar has the advantage over in-situ passive plasma diagnostics in that it provides high-resolution observations of the ambient aerospace environment well beyond the local region disturbed by the instrumented vehicle. The radar can be used both for long-term global observations of the ambient upper atmospheric behavior, and for specific diagnostic support to active space plasma physics experiments such as HF radiowave modification of the ionosphere, wave and chemical injection experiments, and beam-plasma interaction studies.

III. Benefits

A space-based incoherent scatter radar would provide a multi-purpose, global-coverage diagnostic for research studies of the earth's upper atmosphere, with important potential contributions to the investigation of solar-terrestrial relations and in particular to ionosphere-magnetosphere coupling, to the study of communications dependence on the upper atmosphere, and to basic space plasma physics research exploiting the aerospace environment as a large, natural plasma laboratory-without-walls. Such an instrument might also find unique applications to specific radio astronomy observations.

IV. Justification

Virtually an unlimited number of aeronomy and space plasma physics experiments could be supported by a space-based incoherent scatter radar. Such a radar requires long-duration space deployments; large antenna, power source, capacitor bank, and heat dissipation capabilities; and for optimum flexibility, some level of man-machine interfacing. For specific experimental applications, event point tracking would be necessary.

V. Mission Requirements and Capabilities

(a) Orbital Parameters -- Both low inclination and near polar orbits are desirable. Orbital altitudes of 400-500 km are preferred.

(b) Mass, Volume -- TBD, but a large (at least tens of meters) antenna can be anticipated.

(c) Power -- The power requirements depend on a number of inter-related TBD parameters, including antenna size, capacitor bank and heat dissipation limitations, and desired radar transmitter pulsing characteristics and operational duty cycle.

(d) Thermal Control -- TBD, but considerable heat dissipation requirements can be anticipated.

(e) Attitude, Stabilization -- An earth-looking attitude is required. Pointing characteristics may in part be determined by the antenna size and resultant radar beamwidth.

(f) Viewing -- An earth-viewing capability is required. For potential radio astronomy applications this may need to be extended to include full sky coverage.

(g) Environmental Constraints -- TBD, possible RF noise background constraints.

(h, i) Data Management, Communications, Crew Timeline -- For general atmospheric monitoring purposes, unmanned operation may be acceptable. However, for specific experimental observations, manned operation will be necessary for real-time data management.

(j) Operations Schedule, Maintenance, Lifetime -- TBD.

VI. Space Station vs. Free Flyer

Power, capacitor bank, heat dissipation, and antenna size requirements, as well as probable frequent man-machine interfacing needs, determine this radar to be necessarily a space station mission.

PAYLOAD ELEMENT NAME
Topside Digital Ionosonde/HF Radar

CODE G D C D 0 2 4 3

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1997
No. of flights 2
Duration of Flight, days 365

OBJECTIVE

TYPE
- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 3

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 9

DESCRIPTION

Four 100-meter booms erected in right crusiform configuration about the spacestation. Each of the four elements are terminated in a HF receiving cross dipole. Both the plane of the dipole cross and the crusiform are normal to the local vertical. The HF transmitter, computer, and transmitting antenna are located on/in the space station body. Array will require assembly in orbit. Operating HF is 3-30 MHz.

CODE G D C D 0 2 4 3

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 100 - 0
Inclination, deg 28.5 and 90 Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	1500	
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 0 2 4 3

THERMAL

☐ Active ☒ Passive

Temperature, deg C — operational min 10 max 35
non-operational min ____ max ____

Heat Rejection, w — operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 10 W,m 1 H,m 1 Stowed
L,m 200 W,m 200 H,m 3 Deployed

Launch mass, kg 500

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 1

Task Assignment: Operate/Monitor Data

Skills (See Table B)

SKILL	5					
LEVEL	2					
Hrs/Day	0.5					

EVA ☒ YES ☐ NO Reason Ant. Assy/Disassy Hrs/EVA 16

SERVICING/MAINTENANCE

SERVICE: Interval, days ____ Consumables, kg ____
Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Two missions are desired, one at an inclination of 0 degrees (28.5 deg. acceptable) and one at 90° polar orbit. Second flight is in 1999.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0243 ELEMENT NAME TOPSIDE DIG. IONOSONDE/HF RADAR

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S)	INT. HRS	EVA HRS	EVA CREW
1997	4	4	1
1999	4	4	1

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ______ DAYS TOTAL SERVICES ______

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.5 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S)	INT. HRS.	EVA HRS	EVA CREW
1998	4	4	1
2000	4	4	1

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Assemble Antenna plus station OPS
3. Operate/monitor data
5. Remove Antenna plus station OPS

TOTAL EVA HRS 16

Code: GDCD 0243

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Topside Digital Ionosonde/HF Radar

Reference Documents:

1. Space Station Missions Upper Atmospheric Research, Lewis M. Duncan, ESS-7, MS466 Los Almos Nat. Lab., Received September 30, 1982.

2. L.M. Duncan, Telecon February 18, 1982.

Narrative:

This mission was suggested by Dr. Lewis M. Duncan of Los Alamos National Laboratory (Ref 1).

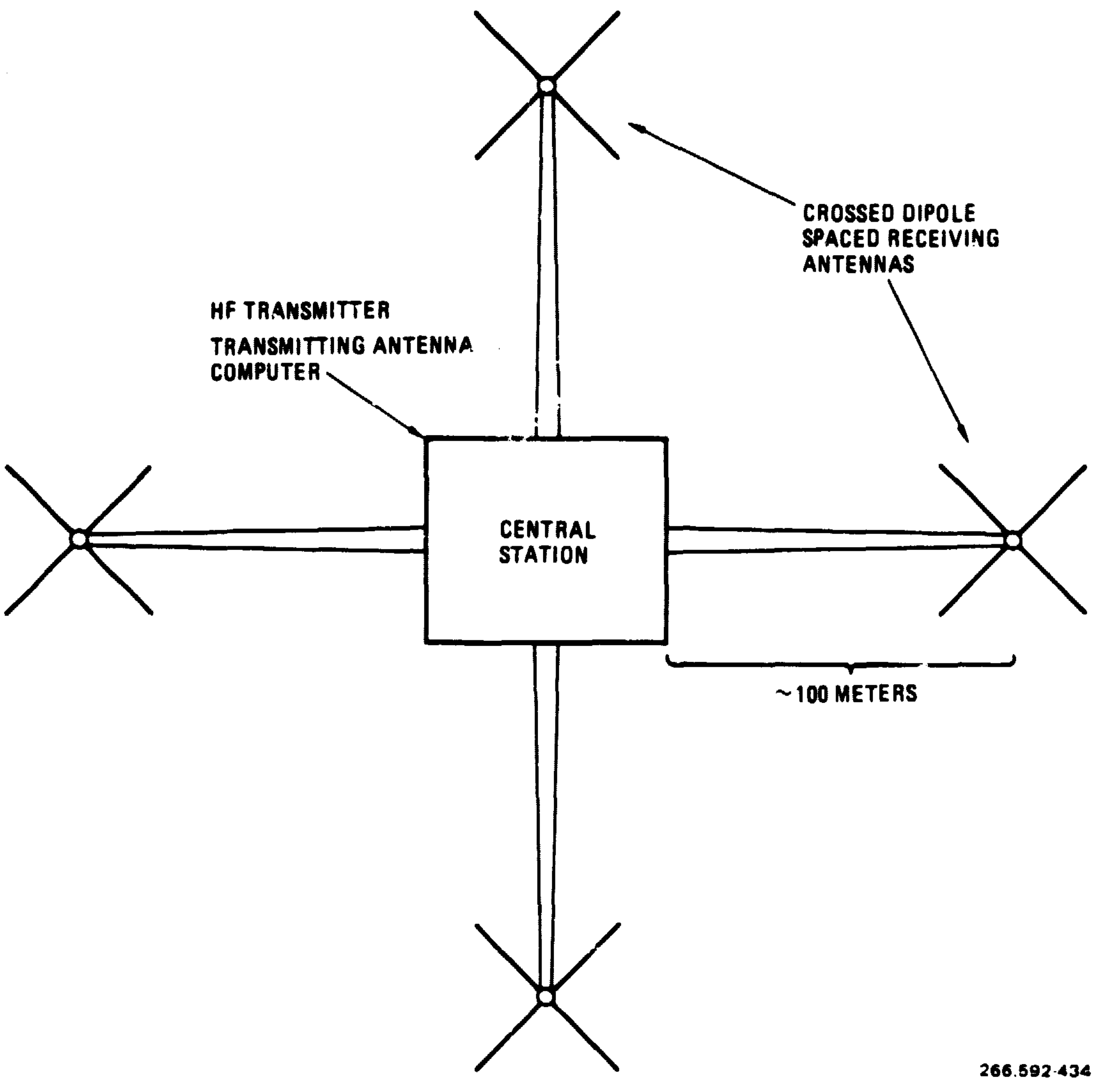
The physical characteristics of the payload element were derived, based on the use of graphite-epoxy expandable boom technology.

This payload element has applications in several scientific disciplines; i.e., Atmospheric Physics, Plasma Physics, and Radio Astronomy. it also has potential as a surveillance radar.

Scientific objectives would benefit most from high or polar inclination orbits.

Launch date and mission duration were derived.

Crew time was averaged over the life of the experiments based on four hours per week per Ref 2.



Topside Digital Ionosonde/HF Radar

INSTRUMENT :

TOPSIDE DIGITAL IONOSONDE / HF RADAR

APPLICATIONS :

BASIC STUDIES OF TOPSIDE IONOSPHERE

SOLAR-TERRESTRIAL RELATIONS

IONOSPHERE-MAGNETOSPHERE COUPLING

HF RADIO ASTRONOMY

SURVEILLANCE

266.592-435

Topside Digital Ionosonde/HF Radar (contd)

WHAT DOES A TOPSIDE DIGITAL IONOSONDE / HF RADAR DO?

HIGH SPATIAL- AND TEMPORAL-
RESOLUTION MEASUREMENTS OF:

TOPSIDE IONOSPHERE ELECTRON DENSITY
- LARGE SCALE STRUCTURE (MORPHOLOGY)
- MEDIUM SCALE STRUCTURE (ACOUSTIC-GRAVITY WAVES)
- SMALL SCALE STRUCTURE /TURBULENCE (SPREAD F)

TOPSIDE VERTICAL LAYER MOTIONS

266.592-436

JUSTIFICATION :

LONG-DURATION, GLOBAL COVERAGE MISSIONS
- SCIENTIFIC
- SURVEILLANCE / NATIONAL SECURITY

LARGE ANTENNA ARRAY

266.592-437

Topside Digital Ionosonde/HF Radar (contd)

Code: GDCU 0243

PAYLOAD ELEMENT SYNTHESIS

DIGITAL TOPSIDE IONOSONDE/HF RADAR

I. Mission Objectives

To develop and operate from near-earth space on HF digital topside ionosonde/HF radar.

II. Mission Description

The proposed mission will provide worldwide observations of upper atmosphere/ionosphere morphology and dynamics through the monitoring of topside ionospheric electron densities and structure motions. HF ionosondes have the advantage over in-situ passive plasma diagnostics in that they provide high-resolution observations of the ambient space environment well beyond the local region disturbed by the instrumented vehicle. The ionosonde can be used both for long term global observations of the ambient topside ionospheric behavior, and for specific diagnostic support to active space plasma physics experiments. In addition, global surveillance coverage of the ionosphere is within the scope of such a spaceborne ionosonde/HF radar.

III. Benefits

A space-based digital HF ionosonde would provide a multi-purpose, global-coverage diagnostic for research studies of the topside ionosphere. Potential contributions to the investigation of (1) solar-terrestrial relationships, (2) ionosphere-magnetosphere coupling dynamics, and (3) space communications are available. In addition, such a facility would allow dramatic advances in the HF radio astronomy field, heretofore "blinded" by the earth's ionospheric shield.

IV. Justification

A large number of ionospheric and space plasma physics experiments could be supported by a space-based digital HF ionosonde. Such an ionosonde requires long-duration space deployments, large antennas and power sources. Although not expected to need constant human attention, for optimum flexibility some level of man-machine interfacing would be required.

V. Mission Requirements and Capabilities

(a) Orbital Parameters -- Both low inclination and near polar orbits are desirable. Orbital altitudes of 400-500 km are preferred.

(b) Mass, Volume -- TBD, but a large (at least tens of meters) antenna array can be anticipated.

(c) Power -- The power requirements depend on a number of inter-related TBD parameters, including antenna size, capacitor bank and heat dissipation limitations, and desired radar transmitter pulsing characteristics and operational duty cycle.

(d) Thermal Control -- TBD, but heat dissipatión requirements can be anticipated to be small.

(e) Attitude, Stabilization -- An earth-looking attitude is required. Pointing characteristics may in part be determined by the antenna size and spacings.

(f) Viewing -- An earth-viewing capability is required. For potential radio astronomy applications this may need to be extended to include full sky coverage, using backlobes of the receiving antennas.

(g) Environmental Constraints -- TBD, possible RF noise background constraints.

(h, i) Data Management, Communications, Crew Timeline -- For general atmospheric monitoring purposes, unmanned operation may be acceptable. However, for specific experimental observations, manned operation may be necessary for real-time data management.

(j) Operations Schedule, Maintenance, Lifetime -- TBD.

VI. Space Station vs. Free Flyer

Antenna size requirements, as well as possible frequent man-machine interfacing needs, determine this radar to be necessarily a space station mission.

PAYLOAD ELEMENT NAME
Solar Terrstl Observatory/Advanced

CODE
G D C D 0 2 4 4

CONTACT
Name / Address: W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 2000
No. of flights 1
Duration of Flight, days 2190

TYPE

☒ Science & Applications (non-commercial)
☐ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 3

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

OBJECTIVE

Simultaneously investigate solar variability, wave-particle processes, magnetosphere-ionosphere mass transport, global electric circuit, upper atmospheric dynamics, middle atmosphere chemistry and energetics, lower atmospheric turbidity, and planetary atmospheric waves.

DESCRIPTION The STO hardware constitutes 17 experiments (a mission itself) grouped onto two single pallets and a two-pallet train. One pallet contains a pointing mount. The chemical release module (CRM) and recoverable plasma diagnostic package will be deployed from the space station. The instruments are: total radiation monitor, UV radiance monitor, soft X-ray telescope, white light and line cronographs, IR spectrometers, X-ray telescope (AXET), UV and visible spectrometer, upper atmospheric temp sounder, upper atmospheric wind sensor, wave injection (WISP), chemical release module, and recoverable plasma diagnostic package.

CODE G D C D 0 2 4 4

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 100 - 100
Inclination, deg 57 Tolerance + 33 - 0
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☒ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec 1800 Field of view, deg 360 Sperical
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	10,000	12
Standby		
Peak	21,000	12

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) 2 Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 42,000 Downlink Frequency (MHZ) ______

CODE G D C D 0 2 4 4

THERMAL

[X] Active [X] Passive (Fluid Loop)

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min 6500 max 15,850
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: [ ] Internal [X] External [ ] Remote

Equipment ID/Function [ ] Pressurized [ ] Unpressurized

L,m 13 W,m 4.5 H,m 4.5 Stowed
L,m 13 W,m 300 H,m 10 Deployed

Launch mass, kg 16,500

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2

Task Assignment: Operate/Point Inst/Analyze Data

Skills (See Table B)

SKILL	4	5				
LEVEL	3	3				
Hrs/Day	0.67	0.67				

EVA [X] YES [ ] NO Reason Service, Reconfig. Hrs/EVA 20

SERVICING/MAINTENANCE

SERVICE: Interval, days 365 Consumables, kg 2500
Returnables, kg ______ Man Hours 4

CONFIGURATION CHANGES: Interval, day 365 Man/Hrs Req. 4
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions The operating power can vary between 10 and 21 Kw over an orbit. Special targets include: Earth's atmosphere and limb, magnetic field lines, auroral zones, Sun, stars, and cold sky. Desired to attain latitude extremes (magnetic) between 2200 and 2400 local time. STO emits particle beam (electron, He, Ar) RF radiation (1-kHz, 0.1-30 MHz, ∿140 Mhz, and ∿400 MHz), laser light (IR-UV), and purge gases (Xe, CH4, and CO_2).

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

CDCD CODE 0244 ELEMENT NAME SOLAR TERR. OBS - ADVANCED

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 2000 INT. HRS ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 365 DAYS [illegible]SERVICES 5

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE 2

☐ NOT APPLICABLE ______ EVA HRS PER SERVICE 2

EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

1-1/3 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 365 DAYS TOTAL RECONFIGS. 5

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 2

☐ NOT APPLICABLE EVA HRS PER RECONFIG. 2

EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Station OPS
2. Assume servicing equipment
3. 2 crew @ 2 hours each 2 days/week (6 day work)
4. Sensor/detector reconfiguration assumed
5. Payload operation continues past year 2000

TOTAL EVA HRS 20

Code: GDCD 0244

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Solar Terrestial Observatory - Advanced

Reference Documents:

1. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982.

Narrative:

This payload element is based upon the STO description originally developed for the MSFC SASP. The mission description and physical characteristics were taken directly from Ref 1, p D-57.

For this late time frame,a manned platform in high inclination (57-90 degrees) orbit is required.

A mission duration of at least six years (one-half of a solar activity cycle) is assumed.

Manned interaction with both natural and artifically-induced phenomena is required. Servicing, updating, resupply and reconfiguration also require manned support. This payload element would be operated intermittantly; i.e., two days per week. A crew of two will be required during operation to monitor, control and coordinate the use of the equipment.

Launch date and mission duration was derived.

Code: GDCD 0244 PAYLOAD ELEMENT SYNTHESIS

SOLAR TERRESTRIAL OBSERVATORY: (STO)

DESCRIPTION

STO contains hardware for 17 flight experiments and constitutes a mission in itself. The instruments are grouped onto two single pallets and a two-pallet train. One of the pallets contains a pointing mount. The Chemical Release module (CRM), a free-flyer, will be launched separately.

OBJECTIVE

The STO science objectives lie in the following areas: Solar Variability, Wave-Particle Processes, Magnetosphere-Ionsphere Mass Transport, Global Electric Circuit, Upper Atmospheric Dynamics, Middle Atmosphere Chemistry and Energetics, lower Atmospheric Turbidity, and Planetary Atmospheric Waves. Investigations in the above-listed areas require extensive simultaneous operation of the STO instruments.

Instruments assigned to each of the four pallets are listed in Table 0244.

SPECIAL CONSIDERATIONS/CLARIFICATIONS

EMMISSIONS/SUSCEPTIBILITIES

Since STO occupies the whole Space Platform, emissions and susceptibilities are an internal matter. In general STO instruments are sensitive to H_2o, CO_2, and optical contaminants effective in the IR-visible-UV spectral regions. STO emits particle beams (electrons, He, and Ar) rf radiation (1-30 kHz 0.1 MHz, -140 MHz, and -400 MHz), laser light (IR-UV), and purge gases (Xe, CH, and CO_2).

VIEWING REQUIREMENTS

STO instruments have a variety of viewing requirements to include solar, limb, limb through solar occultation, nadir, and magnetic field pointing. Desire attainment of latitude extremes (magnetic) between 2200 and 2400 local time.

Table 0244
Solar Terrestrial Observatory (STO) Instruments

ACRONYM	NAME	FUNCTION
1. ACR	Active Cavity Radiometer	Total irradiance monitor
2. SUSIM	Solar Ultraviolet Spectral Irradiance Monitor	UV irradiance monitor
3. SX	Soft X-Ray Telescope	
4. Lyman Alpha	White Light Coronagraph	
5. ATMOS-P	Atomspheric Time Molecules Observed by Spectroscopy	IR Spectrometers Absorption/Emission
6. ERBE	Earth Radiation Budget Experiment	Radiation Balance Monitor
7. SEPAC	Space Experiments with Particle Accelerators	Particle Injector
8. MMP	Magnetospheric Multiprobes	F.F. Plasma Measurement Installation
9. LIDAR	Light Detection and Ranging Facility	
10. AEPI	Atmospheric Emission Photometric Imaging	Low Light Level TV
11. MX	Atmospheric X-Ray Telescope (AXET)	Aural Monitor
12. ISO	Imaging Spectrometric Observatory	UV and Visible Spectrometer
13. ALS	Advanced Limb Scanner	Upper Atmospheric Temperature Sounder
14. HRDI	High Resolution Doppler Imager	Upper Atmospheric Wind Sensor
15. WISP	Waves In Space Plasmas	
16. CRM	Chemical Release Module	
17. RPDP	Recoverable Plasma Diagnostic Package	Subsatellite

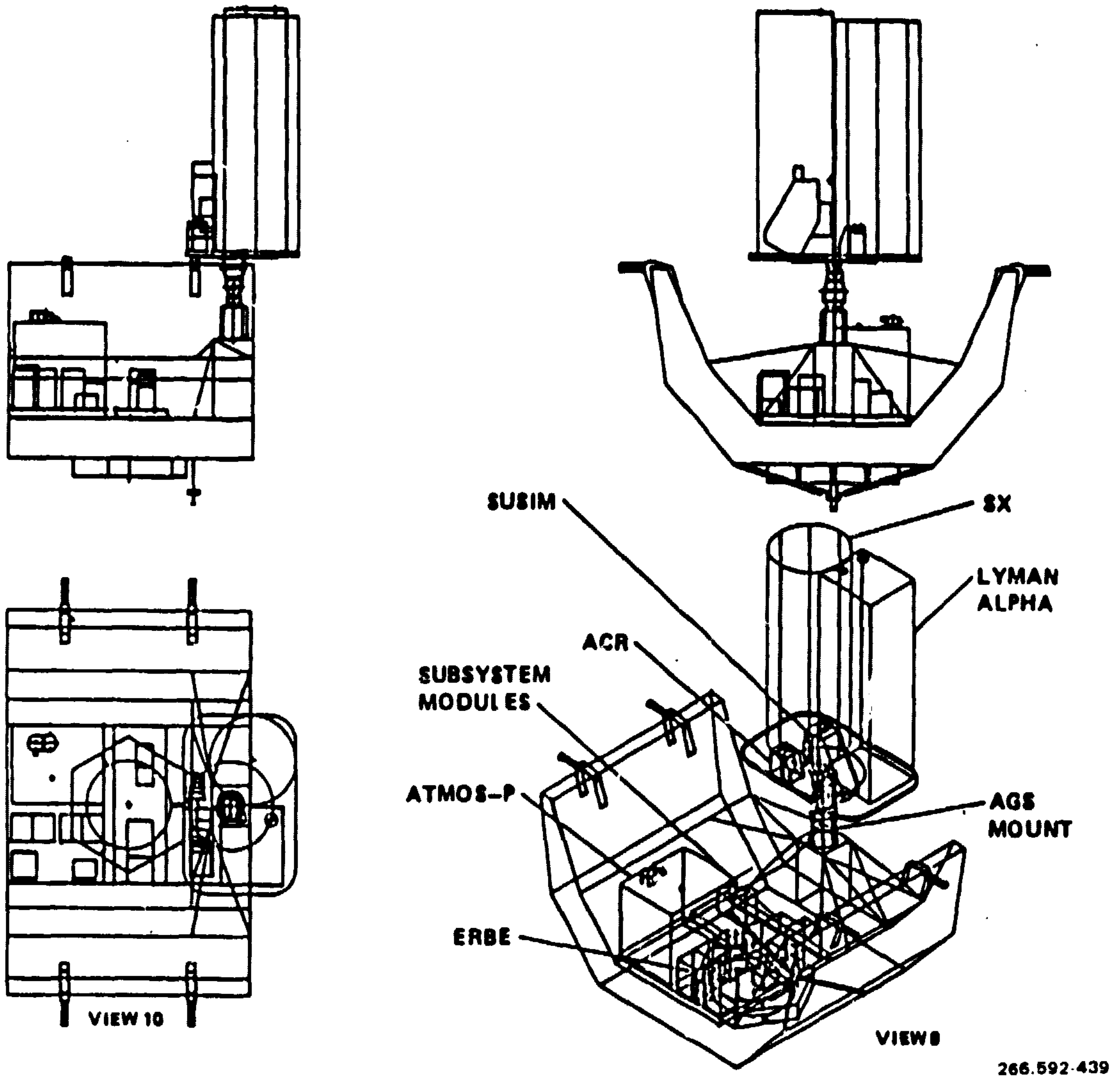
Code: GDCD 0244

PAYLOAD ELEMENT SYNTHESIS

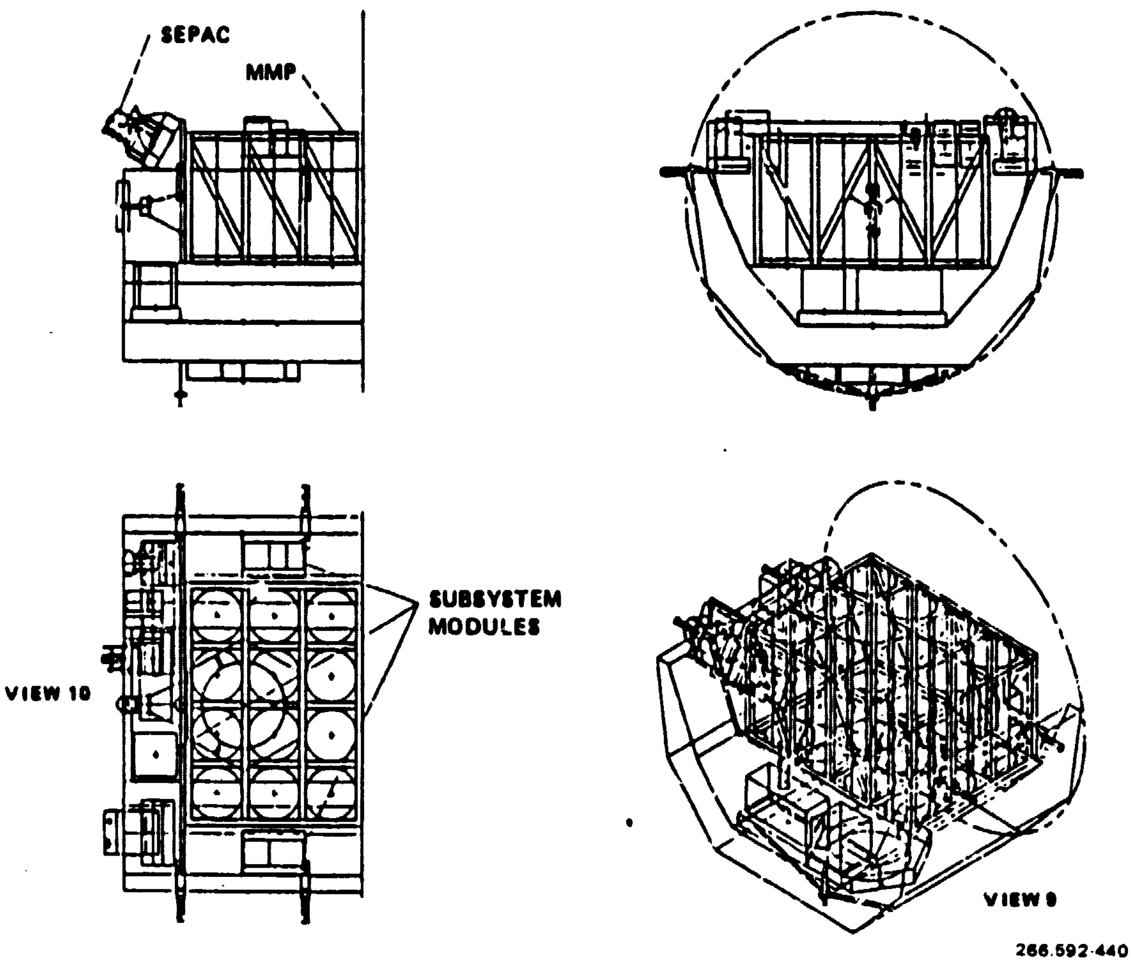
SP PORT		INSTRUMENT	ACRONYM	WEIGHT (kg)	% PALLET AREA	POWER (W) OP./PEAK	THERMAL CONTROL	DATA (kbps) LO/HR	OPERATION	POINTING ACCOM.
+Y	1	TOTAL IRRADIANCE MONITOR	ACR	20	5	10/13	Cold plate	0.217/NA	Sun Av.	Fixed
	2	UV IRRADIANCE MONITOR	SUSIM	84	<10	123/153	Passive	0.531/NA	Sun Av.	Fixed
	3	SOFT X-RAY TELESCOPE	SX	466	25	70/106	Passive	TBD/3.8 + 400	Sun Av.	AGS
	4	WHITE LIGHT CORONAGRAPH RESONANCE LINE CORONAGRAPH	LYMAN ALPHA	250	25	87/200	Passive	TBD/13.5	Sun Av.	AGS
	5	IR ABSORPTION SPECTROMETER IR EMISSION SPECTROMETER	ATMOS-P	300	15	310/370	Cold Plate	NA/1.28 15,760	Sunset/rise	Built in
	6	RADIATION BALANCE MONITOR	ERBE	65	5	52/60	Passive	1.120/NA	Cont.	Built in
−Y	7	PARTICLE INJECTOR	SEPAC	637	25	1000/3000	Cold plates	1.4/512 + TV + HB An.	High Mass. Lat., Night	Built in
	8	MULTIPROBES	MMP	1692	<50	143/143	Passive	TBD/60	Cont.	--
+X	9	LIDAR	LIDAR	1900	100	3500/4600	Cold plates	TBD/253	Intermit.	Body Ptg.
	10	LOW LIGHT LEVEL TELEVISION	AEPI	174	<10	340/560	Cold Plate	1.0/277 + TV	SEPAC/WISP	MAST
	11	X-RAY TELESCOPE (AXET)	HX	210	<10	196/294	Passive	TBD/~10	Cont.	Fixed
	6	RADIATION BALANCE MONITOR	ERBE	55	5	52/60	Passive	1.120/NA	Cont.	Built in
	12	UV AND VISIBLE SPECTROMETER	ISO	245	<15	190/216	Cold Plate	0.001/125 or 2000	Day/Night	Built in
	13	UPPER ATMOSPHERIC TEMPERATURE SOUNDER	ALS	72	<10	165/190	Cold Plate	TBD/8	Cont.	Fixed
	14	UPPER ATMOSPHERIC WIND SENSOR	WNDI	76	<10	82/150	Passive	TBD/4	Day	Built in
	15	WISP	WISP	732	<50	1000/7000	Cold plates	TBD/7000	Day/Night	Body Ptg.
FREEFLYERS SEPARATE LAUNCH	16	CHEMICAL RELEASE MODULE	CRM	1900	100	NO STO-ATTACHED HARDWARE				
	17	RECOVERABLE PLASMA DIAGNOSTIC PACKAGE	RPDP	440	<40	50/50	Cold plate	0.296/32 + 1200	Cont.	--

Summary of Characteristics and Requirements for STD Instruments

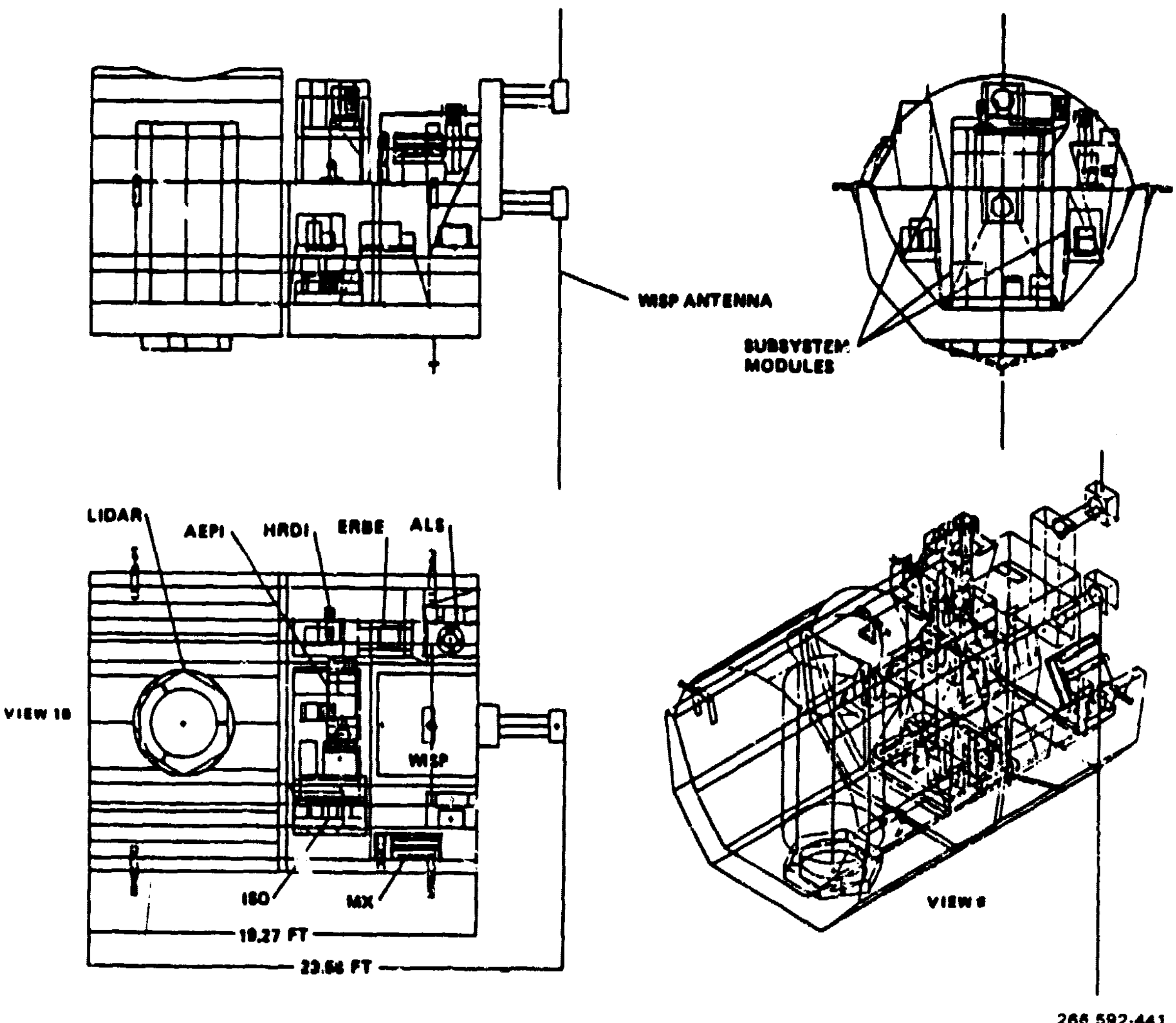
266.592.438



+Y Axis Pallet



-Y Axis Pallet



+X Axis Pallet

PAYLOAD ELEMENT NAME
Space Plasma Physics P1/Advanced

CODE G D C D 0 2 4 5

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 1998
No. of flights 1
Duration of Flight, days 730

OBJECTIVE

Study space plasma/atmospheric interactions utilizing observations of natural and induced atmospheric emissions.

TYPE

☒ Science & Applications (non-commercial)
☐ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 3

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

DESCRIPTION

The SPP payload contains the following instruments: wave injection (WISP), solar monitors (ACM, SUSIM, X-ray), low light TV (AEPI), X-ray telescope (AXET), UV and visible (ISO). Subsatellite (PPDP) and multiprobes (MP) are included. The integration hardware includes an active thermal control loop, a shelf and a special structure for mounting the WISP dipole antenna. The SPP is packaged on a spacelab pallet.

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OF POOR QUALITY

CODE GDCD0245

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 100 – 150
Inclination, deg 57 Tolerance + 33 – 0
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☒ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec 3600 Field of view, deg ±40 × 90
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	3225	1.0
Standby	600	0.5
Peak	12,000	0.1

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) 2 Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 12,000 Downlink Frequency (MHZ) ______

CODE G D C D 0 2 4 5

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 5 W,m 4.5 H,m 4.5 Stowed
L,m 5 W,m 300 H,m 10 Deployed

Launch mass, kg 3183

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1 Task Assignment ______

Skills (See Table B)

SKILL	3					
LEVEL	2					
Hrs/Day	0.5					

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days 180 Consumables, kg 20
Returnables, kg ______ Man Hours 16

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Coordination with observatories on ground is required for wave injection (WISP) and particle injection (SEPAC) objectives. A baseline scenario devotes one week/month of intensive operation of the WISP and SEPAC. Coordinated transmissions (interleaved pulses) is a SEPAC/WISP operational objective.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0245 ELEMENT NAME SPACE PLASMA PHYSICS P/L - ADVANCED

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1998 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 180 DAYS TOTAL SERVICES 3

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE 16

   ☐ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.5 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) 2000 INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Station OPS
3. Monitor
5. Assume Station OPS

TOTAL EVA HRS 0

Code: GDCD 0245

PAYLOAD ELEMENT SYNTHESIS

Payload Element Names: Space Plasma Physics Payload - Advanced

Reference Documents:

1. Space Platform Payload Data, Science and Application Space Platform payload Accommodations Study, SP82-MSFC-2583, March 1982.

Narrative:

This payload element is based upon the Space Plasma Physics (SPD) descriptions originally developed for the MSFC SASP. The mission description and physical characteristics were taken directly from Ref 1, p D-14.

For this late time frame, a manned platform in high inclination orbit is required.

After two years of on-orbit development and operations, the instruments of this payload element become part of the STO (GDCO-0244).

Launch date and mission duration were derived.

Space Plasma Physics - SPP

DESCRIPTION

The SPP payloads contains the SEPAC, WISP, and AEPI instruments. The integration hardware includes an active thermal control loop, a shelf on which to mount the SEPAC electron gun, MPD arcjet, and instruments, and a special structure for mounting the WISP dipole antenna. The SPP payload is packaged on a Spacelab pallet.

INSTRUMENTS

SEPAC = Space Experiments with Particle Accelerators.

WISP = Waves in Space Plasmas.

AEPI = Atmospheric Emission Photometric Imaging.

OPERATIONAL CONSIDERATIONS

As a baseline scenario devote 1 week/month of intensive operation to SEPAC and WISP. Assuming WISP is in a passive mode while SEPAC is operating and vice versa. Provide additional operation where resources permit. Coordinated transmissions (interleaved pulses) is a SEPAC/WISP operational objective and capability to support such operation should be assessed. AEPI is included in the payload only to support SEPAC and WISP FOs. AEPI is desired for all SEPAC operations and some WISP operations. AEPI is typically pointed along the magnetic field line to look for an auroral spot.

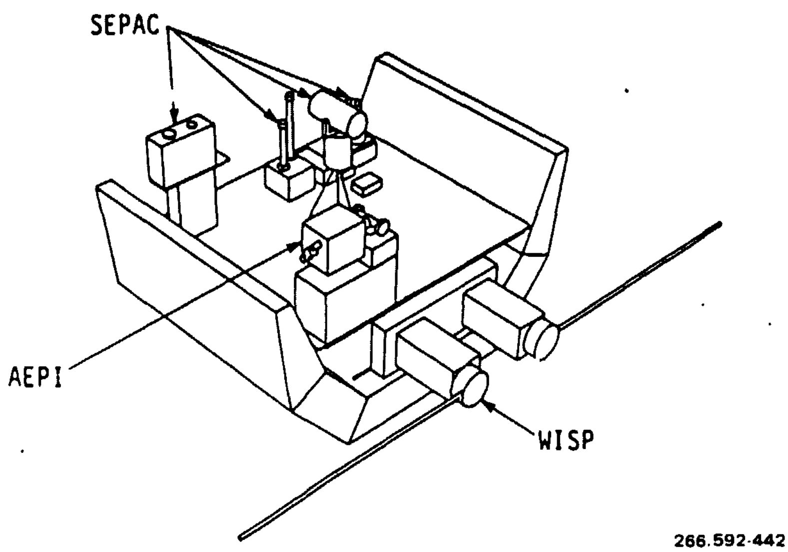
SPECIAL CONSIDERATIONS/CLARIFICATIONS

<u>EMISSIONS/SUSCEPTIBILITIES:</u>

SEPAC emits an electronic beam (1-20 keV energy, 1-25 kW power), a He or Ar Magneto-plasma-dynamic arcjet (2-10 kJ pulse, 250 eV particle energy), and a neutral gas plume. WISP transmits high power plasma/ radio waves in two broadcast bands, VLF (1-30 kHz) and HF (0.1-30 mHz). AEPI is sensitive to standard optical contaminants.

VIEWING REQUIREMENTS:

A 45 degree (half angle) avoidance cone is required for the SEPAC particle beams. The electron beam has a divergence angle of -5 degrees and is steerable with a 30 degree (half angle) cone. The WISP dipole antenna must have a clear view to space. Most SEPAC and WISP functional objectives (FOs) require pointing with respect to the geomagnetic field vector. AEPI would point along magnetic field lines to support SEPAC and AEPI FOs.



Space Plasma Physics Group

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PAYLOAD ELEMENT NAME
Solar Terrestrial Observatory

CODE GDCD0246

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1994
No. of flights 1
Duration of Flight, days 365

TYPE
- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 3

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 5

OBJECTIVE

Simultaneously investigate solar variability, wave particle processors, magnetosphere-ionosphere mass transport, global electric circuit, upper atmospheric dynamics, middle atmosphere chemistry and energetics, lower atmospheric turbidity, and planetary atmospheric waves.

DESCRIPTION The STO hardware constitutes 17 experiments (a mission itself) grouped onto two single pallets and a two-pallet train. One pallet contains a pointing mount. The chemical release module (CRM) and recoverable plasma diagnostic package will be deployed from the Space Staion. The instruments are: total radiation monitor, UV radiance monitor, soft X-ray telescope, white light and line cronographs, IR spectrometers, radiation balance monitor (2), particle injector, multiprobes, LIDAR, LLL Television, X-ray telescope (AXET), UV and visible spectrometer, upper atmosphere; C temp sounder, upper atmospheric wind sensor, wave injection (WISP), chemical release module, and recoverable plasma diagnostic package.

CODE G D C D 0 2 4 6

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 100 - 100
Inclination, deg 57 Tolerance + 33 - 0
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☒ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec 1800 Field of view, deg 360 Sperical
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	10,000	12
Standby		
Peak	21,000	12

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 42,000 Downlink Frequency (MHZ) ______

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CODE GDCD0246

THERMAL

[X] Active [X] Passive (Fluid Loop)

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min 6500 max 15,850
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: [ ] Internal [X] External [ ] Remote

Equipment ID/Function [ ] Pressurized [ ] Unpressurized

L,m 13 W,m 4.5 H,m 4.5 Stowed
L,m 13 W,m 300 H,m 10 Deployed

Launch mass, kg 16,500

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2 Task Assignment Operate/Point Instr

Skills (See Table B)

SKILL	5	4				
LEVEL	3	3				
Hrs/Day	1	1				

EVA [X] YES [ ] NO Reason ______ Hrs/EVA 8

SERVICING/MAINTENANCE

SERVICE: Interval, days 180 Consumables, kg 2500
Returnables, kg ______ Man Hours 16

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

The operating power can vary between 10 and 21 Kw over an orbit. Special targets include: Earth's atmosphere and limb, magnetic field lines, Auroral zones, sun, stars and cold sky. Desired to attain latitude extremes (magnetic) between 2200 and 2400 local time. Instruments sensitive to: H_2O, CO_2 and IR-visible - UV spectral region contamination. STO emits particle beam (electrons, He, AR) RF radiaiton (1-KHz, 0.1 -30 MHz, ~140 MHz, and ~400 MHz), laser light (IR-UV), and purge gases (Xe, CH4 and CO_2).

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0246 ELEMENT NAME SOLAR TERRESTRIAL OBSERVATORY

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER* ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1994 INT. HRS ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 180 DAYS TOTAL SERVICES 1

   ☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE 8

   ☐ NOT APPLICABLE ______ EVA HRS PER SERVICE 8

   EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   2 HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ______ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) 1995 INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

* Free flyer accommodation is an alternate mode, and if used will require re-evaluation of all requirements.

1. and 5. above - assume station operations
2. Service on probe/satellite consumables
3. Operate/point instruments and analyze data

TOTAL EVA HRS 8

Code: GDCD 0246

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Solar Terrestrial Observatory - (STO)

Reference Documents:

1. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982.

Narrative:

This payload element is the same as the STO description originally developed for the MSFC unmanned SASP. The mission description and physical characteristics were taken directly from Ref 1, p D-57.

For this early time frame, a manned accommodation is preferred although an unmanned platform in high inclination orbit (57 degrees) is acceptable.

Launch date and mission duration were derived.

Solar Terrestrial Observatory (STO)

DESCRIPTION

STO contains hardware for 17 flight experiments and constitues a mission in itself. The instruments are grouped onto two single pallets and a two-pallet train. One of the pallets contains a pointing mount. The Chemical Release Module (CRM), a free-flyer, will be launched separately.

OBJECTIVE

The STO science objectives lie in the following areas: Solar Variability, Wave-Particle Processes, Magnetosphere-Ionsphere Mass Transport, Global Electric Circuit, Upper Atmospheric Dynamics, Middle ATmosphere Chemistry and Energetics, lower Atmospheric Turbidity, and Planetary Atmospheric Waves. Investigations in the above-listed areas require extensive simultaneous operation of the STO instruments.

Instruments assigned to each of the four pallets are listed in Table 0246.

SPECIAL CONSIDERATIONS/CLARIFICATIONS

EMISSIONS/SUSCEPTIBILITIES

Since STO occupies the whole Space Platform, emissions and susceptibilities are an internal matter. In general STO instruments are sensitive to H_2O, CO_2, and optical contaminants effective in the IR-visible-UV spectral regions. STO emits particle beams (electrons, He, and Ar) rf radiation)1-30 kHz 01.-30 MHz, -140 MHz, and -400 MHz), laser light (IR-UV), and purge gases (Xe, CH, and CO_2).

VIEWING REQUIREMENTS

STO instruments have a variety of viewing requirements to include solar, limb, limb through solar occultation, nadir, and magnetic field pointing.
Desire attainment of latitude extremes (magnetic) between 2200 and 2400 local time.

Table 0246
Solar Terrestrial Observatory (STO) Instruments

ACRONYM	NAME	FUNCTION
1. ACR	Active Cavity Radiometer	Total irradiance monitor
2. SUSIM	Solar Ultraviolet Spectral Irradiance Monitor	UV irradiance monitor
3. SX	Soft X-Ray Telescope	
4. Lyman Alpha	White Light Coronagraph	
5. ATMOS-P	Atomspheric Time Molecules Observed by Spectroscopy	IR Spectrometers Absorption/Emission
6. ERBE	Earth Radiation Budget Experiment	Radiation Balance Monitor
7. SEPAC	Space Experiments with Particle Accelerators	Particle Injector
8. MMP	Magnetospheric Multiprobes	F.F. Plasma Measurement Installation
9. LIDAR	Light Detection and Ranging Facility	
10. AEPI	Atmospheric Emission Photometric Imaging	Low Light Level TV
11. MX	Atmospheric X-Ray Telescope (AXET)	Aural Monitor
12. ISO	Imaging Spectrometric Observatory	UV and Visible Spectrometer
13. ALS	Advanced Limb Scanner	Upper Atmospheric Temperature Sounder
14. HRDI	High Resolution Doppler Imager	Upper Atmospheric Wind Sensor
15. WISP	Waves In Space Plasmas	
16. CRM	Chemical Release Module	
17. RPDP	Recoverable Plasma Diagnostic Package	Subsatellite

SP PORT		INSTRUMENT	ACRONYM	WEIGHT (kg)	% PALLET AREA	POWER (W) OP./PEAK	THERMAL CONTROL	DATA (kbps) LR/HR	OPERATION	POINTING ACCOM.
+Y	1	TOTAL IRRADIANCE MONITOR	ACR	20	5	10/13	Cold plate	0.217/NA	Sun Av.	Fixed
	2	UV IRRADIANCE MONITOR	SUSIN	84	<10	123/153	Passive	0.531/NA	Sun Av.	Fixed
	3	SOFT X-RAY TELESCOPE	SX	465	25	70/105	Passive	TBD/3.8 + 400	Sun Av.	AGS
	4	WHITE LIGHT CORONAGRAPH RESONANCE LINE CORONAGRAPH	LYMAN ALPHA	250	25	87/280	Passive	TBD/13.5	Sun Av.	AGS
	5	IR ABSORPTION SPECTROMETER IR EMISSION SPECTROMETER	ATMOS-P	300	15	310/370	Cold Plate	NA/1.28 15,760	Sunset/rise	Built in
	6	RADIATION BALANCE MONITOR	ERBE	55	5	52/60	Passive	1.120/NA	Cont.	Built in
−Y	7	PARTICLE INJECTOR	SEPAC	637	25	1000/3000	Cold plates	1.4/612 + TV + WB An.	High Mass, Lat., Night	Built in
	8	MULTIPROBES	MMP	1692	<50	143/143	Passive	TBD/60	Cont.	--
+X	9	LIDAR	LIDAR	1900	100	3500/4500	Cold plates	TBD/253	Intermit.	Body Ptg.
	10	LOW LIGHT LEVEL TELEVISION	AEPI	174	<10	340/560	Cold Plate	1.0/277 + TV	SEPAC/WISP	MAST
	11	X-RAY TELESCOPE (AXET)	MX	210	<10	196/294	Passive	TBD/-10	Cont.	Fixed
	6	RADIATION BALANCE MONITOR	ERBE	55	5	52/60	Passive	1.120/NA	Cont.	Built in
	12	UV AND VISIBLE SPECTROMETER	ISO	245	<15	190/216	Cold Plate	0.001/125 or 2000	Day/Night	Built in
	13	UPPER ATMOSPHERIC TEMPERATURE SOUNDER	ALS	72	<10	165/190	Cold Plate	TBD/8	Cont.	Fixed
	14	UPPER ATMOSPHERIC WIND SENSOR	HRDI	76	<10	82/150	Passive	TBD/4	Day	Built in
	15	WISP	WISP	732	<50	1000/7000	Cold plates	TBD/7000	Day/Night	Body Ptg.
FREEFLYERS SEPARATE LAUNCH	16	CHEMICAL RELEASE MODULE	CRM	1900	100	NO STD-ATTACHED HARDWARE				
	17	RECOVERABLE PLASMA DIAGNOSTIC PACKAGE	RPDP	440	<40	50/50	Cold plate	0.296/32 + 1200	Cont.	--

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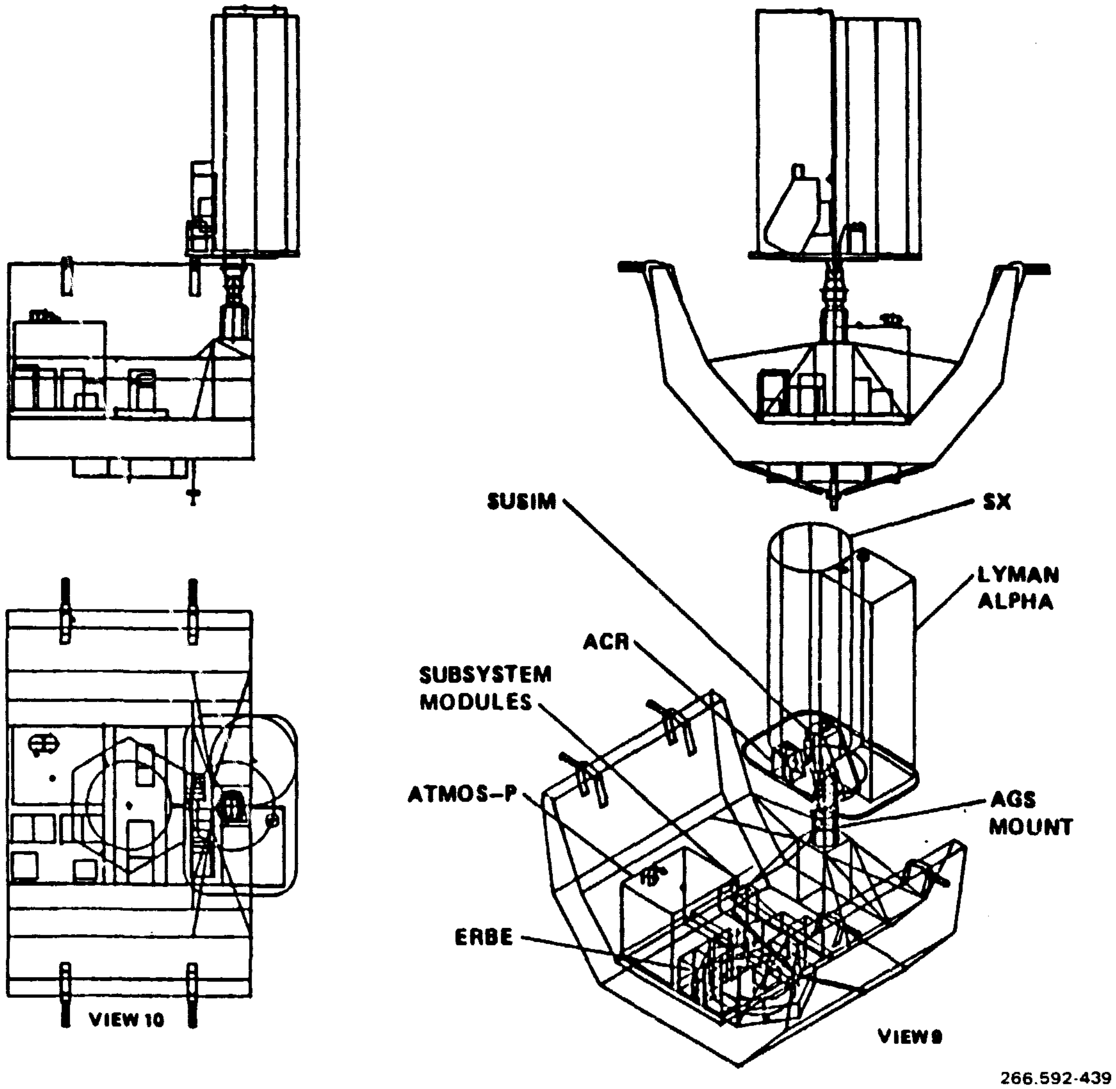
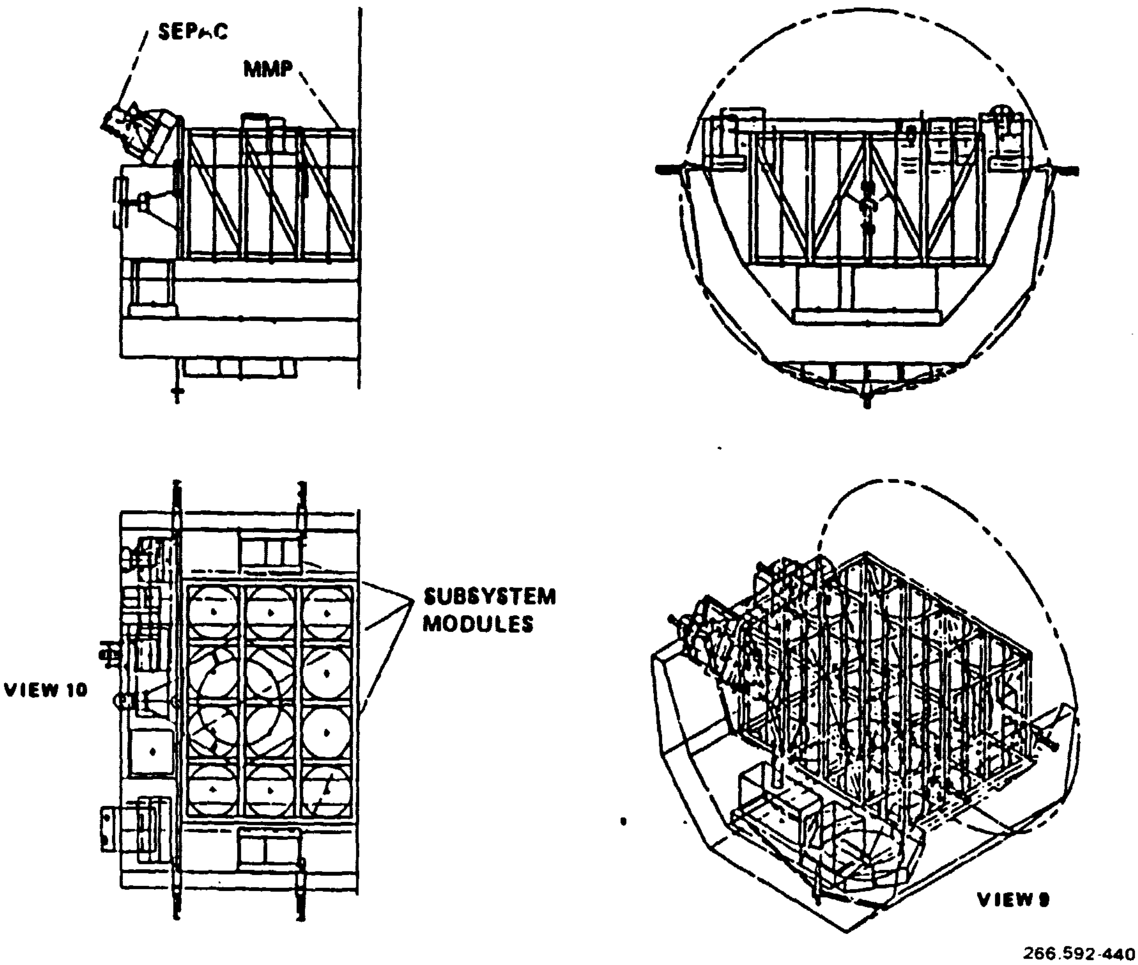
Summary of Characteristics and Requirements for STD Instruments

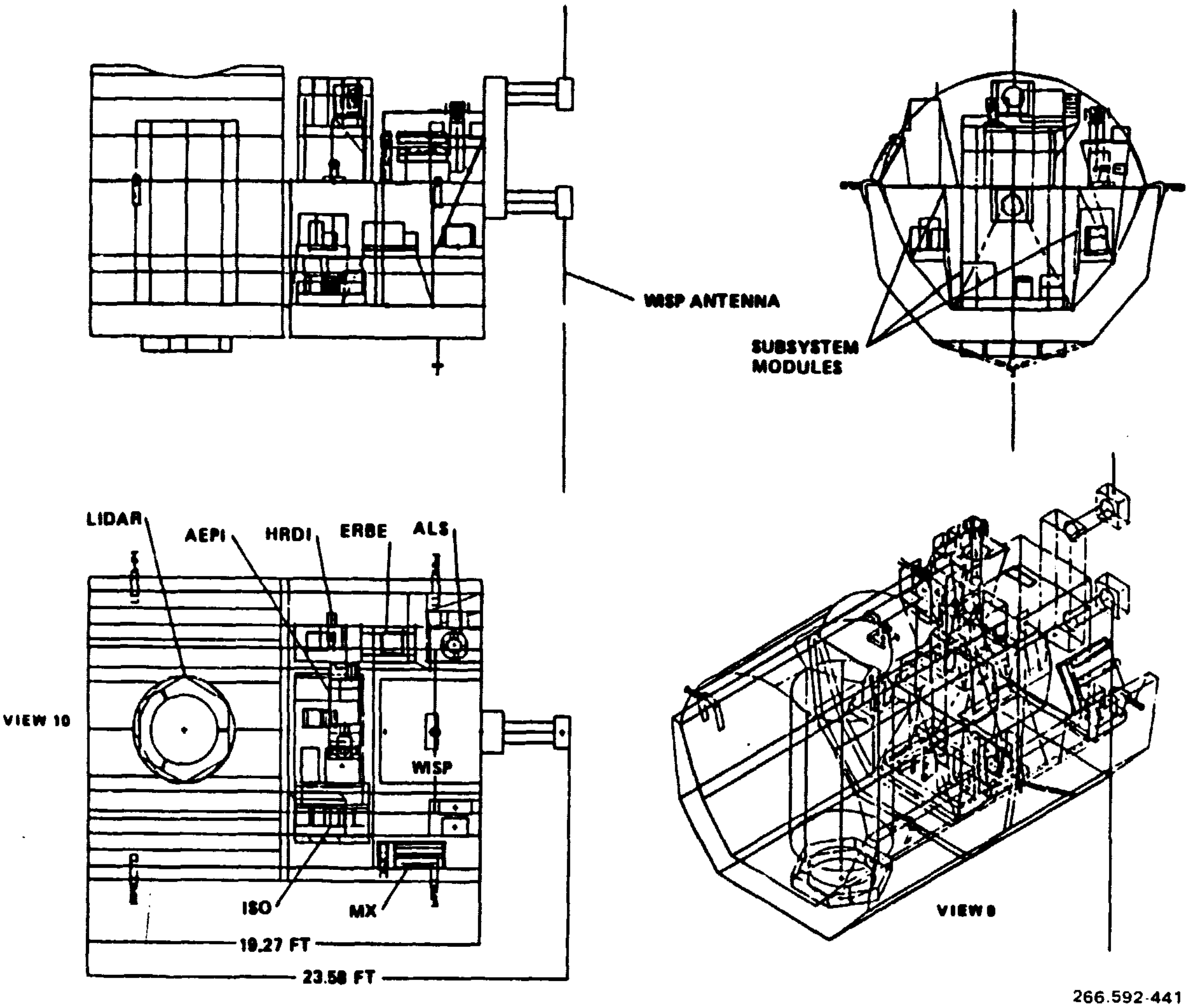
C-5



+Y Axis Pallet



–Y Axis Pallet



+X Axis Pallet

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PAYLOAD ELEMENT NAME
Space Plasma Physics P1

CODE G D C D 0 2 4 7

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- [ ] Operational
- [ ] Approved
- [ ] Planned
- [x] Candidate
- [ ] Opportunity

First flight, yr 1992
No. of flights 1
Duration of Flight, days 365

TYPE

- [x] Science & Applications (non-commercial)
- [ ] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A) 3

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

OBJECTIVE

Study space plasma/atmospheric interactions utilizing observations of natural and induced atmospheric emissions.

DESCRIPTION

The SPP payload contains the following instruments: wave injection (WISP), solar monitor (ACM, SUSIM, X-ray), low light TV (AEPI), X-ray telescope (AXET), UV and visible (ISO). Subsatellites (PPDP) and multiprobes (MP) are included. The integration hardware includes an active thermal control loop, a shelf on which mounts the SEPAC electron gun, MPD arcjet, and instruments, and a special structure for mounting the WISP dipole antenna. The SPP is packaged on a spacelab pallet.

CODE G D C D 0 2 4 7

ORBIT CHARACTERISTICS

Apogee, km 500 Perigee, km 500 Tolerance + 100 - 150

Inclination, deg 57 Tolerance + 33 - 0

Nodal Angle, deg ______ Ephemeris Accuracy, m ______

Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☒ Solar ☒ Earth

Truth Sites (if known) ______

Pointing accuracy, arc sec 3600 Field of view, deg ±40 × 90

Pointing Stability (Jitter) arc sec/sec ______

Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	3225	1.0
Standby	600	0.5
Peak	12,000	0.1

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☒ Realtime ☐ Offline ☐ Other ______

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______

☐ On-Board Data Processing Required

Description ______

Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day ______

Film (Amount) ______ Voice (Hrs/Day) ______

Live TV (Hrs/Day) 2 Other ______

On-Board Storage (MBIT) ______

Data Dump Frequency (Per Orbit) ______

Recording Rate (KBPS) 12,000 Downlink Frequency (MHZ) ______

CODE GDCD0247

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 5 W,m 4.5 H,m 4.5 Stowed

L,m 5 W,m 300 H,m 10 Deployed

Launch mass, kg 3183

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1

Task Assignment ______

Skills (See Table B)

SKILL	3					
LEVEL	2					
Hrs/Day	0.25					

EVA ☒ YES ☐ NO Reason Service Hrs/EVA 8

SERVICING/MAINTENANCE

SERVICE: Interval, days 180 Consumables, kg 2150

Returnables, kg ______ Man Hours 16

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Coordination with observatories on ground is required for wave injection (WISP) and particle injection (SEPAC) objectives. A baseline scenario devotes one week/month of intensive operation of the WISP and SEPAC. Coordinated transmissions (interleaved pulses) is a SEPAC/WISP operational objective.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0247 ELEMENT NAME SPACE PLASMA PHYSICS PAYLOAD

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER* ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1992 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 180 DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE 8

   ☐ NOT APPLICABLE ____ EVA HRS PER SERVICE 8

   EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.25 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) 1993 INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

* Free flyer accommodation is an alternate mode, and if used will require re-evaluation of all requirements.

1.and 5. above - assume station operations
2. Service for probe/satellite consumables
3. Monitor data

TOTAL EVA HRS 8

Code: GDCD 0247

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Space Plasma Physics Payload

Reference Documents:

1. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982.

Narrative:

This payload element is based upon the Space Plasma Physics (SPP) description originally developed for the MSFC unmanned SASP. The mission description and physical characteristics were taken directly from Ref 1, p D-14.

For this early time frame a manned accommodation is preferred although an unmanned platform in high inclination (57-90 degrees) is acceptable.

After a year of on-orbit development and operations, the instruments of this payload element become part of the STO (GDCD-0246).

Launch date and mission duration were derived.

Code: GDCD 0247 PAYLOAD ELEMENT SYNTHESIS

Space Plasma Physics - SPP

DESCRIPTION

The SPP payloads contains the SEPAC, WISP, and AEPI instruments. The integration hardware includes an active thermal control loop, a shelf on which to mount the SEPAC electron gun, MPD arcjet, and instruments, and a special structure for mounting the WISP dipole antenna. The SPP payload is packaged on a Spacelab pallet.

INSTRUMENTS

SEPAC = Space Experiments with Particle Accelerators.

WISP = Waves in Space Plasmas.

AEPI = Atmospheric Emission Photometric Imaging.

OPERATIONAL CONSIDERATIONS

As a baseline scenario devote 1 week/month of intensive operation to SEPAC and WISP. Assuming WISP is in a passive mode while SEPAC is operating and vice versa. Provide additional operation where resources permit. Coordinated transmissions (interleaved pulses) is a SEPAC/WISP operational objective and capability to support such operation should be assessed. AEPI is included in the payload only to support SEPAC and WISP FOs. AEPI is desired for all SEPAC operations and some WISP operations. AEPI is typically pointed along the magnetic field line to look for an auroral spot.

SPECIAL CONSIDERATIONS/CLARIFICATIONS

EMISSIONS/SUSCEPTIBILITIES:

SEPAC emits an electronic beam (1-20 keV energy, 1-25 kW power), a He or Ar Magneto-plasma-dynamic arcjet (2-10 kJ pulse, 250 eV particle energy), and a neutral gas plume. WISP transmits high power plasma/ radio waves in two broadcast bands, VLF (1-30 kHz) and HF (0.1-30 mHz). AEPI is sensitive to standard optical contaminants.

VIEWING REQUIREMENTS:

A 45 degree (half angle) avoidance cone is required for the SEPAC particle beams. The electron beam has a divergence angle of -5 degrees and is steerable with a 30 degree (half angle) cone. The WISP dipole antenna must have a clear view to space. Most SEPAC and WISP functional objectives (FOs) require pointing with respect to the geomagnetic field vector. AEPI would point along magnetic field lines to support SEPAC and AEPI FOs.

PAYLOAD ELEMENT NAME
High Resolution Doppler Imager

CODE
G D C D 0 2 6 1

TYPE
☒ Science & Applications (non-commercial)
☐ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 3

CONTACT
Name / Address
W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 365

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 6

OBJECTIVE

Direct measurement of middle atmosphere winds.

DESCRIPTION

The high resolution doppler imager (HRDI) will be employed to measure doppler shift in visible emission limb. (Later part of GDCD 0265 and 0267 UARS payloads, and 0244 and 0246 STO.)

HRDI is an imaging triple etalon Fabry-Perot interferometer fed by a two-axis gimbaled telescope. It observes absorption features of O_2 and bands in the scattered light in the 10-50 km altitude range and atmospheric emission features in the 60-300 km altitude range. Velocity broadening and doppler-shift measured. Both-side viewing desired. Desired wind measurement accuracy is 5m/sec.

CODE G D C D 0 2 6 1

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 200 - 100
Inclination, deg 57 Tolerance + 33 - 0
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth Limb
Truth Sites (if known) ______
Pointing accuracy, arc sec 10800 Field of view, deg ±45 Azimuth
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	82	12
Standby		
Peak		

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 4 Downlink Frequency (MHZ) ______

CODE G D C D 0 2 6 1

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min ____ max ____
non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 2 W,m 2 H,m 1 Stowed
L,m 2 W,m 2 H,m 2 Deployed

Launch mass, kg 76

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 1 Task Assignment Calibration/Monitor

Skills (See Table B)

SKILL	3					
LEVEL	2					
Hrs/Day	0.1					

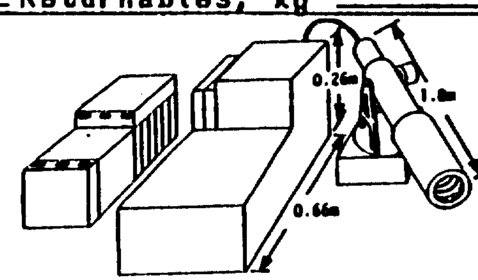
EVA ☐ YES ☒ NO Reason ____ Hrs/EVA ____

SERVICING/MAINTENANCE

SERVICE: Interval, days ____ Consumables, kg ____
Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions



EMISSIONS/SUSCEPTIBILITIES: Sensitive to emission or absorption in lines measured, and to deposition on optics.
OPERATIONAL REQUIREMENTS: HRDI operates in daylight only. Observations are made of the Earth's limb at azimuth angles of 45 and 135° with respect to the velocity vector. Measurement of one wind component requires one scan (20 sec), one side viewing. Measurement of two wind components requires two scans spaced 136 seconds apart, one side viewing.

GOCD CODE 0261 ELEMENT NAME HIGH RESOLUTION DOPPLER IMAGER (HDRI)

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER* ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1990 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.1 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) 1991 INT. HRS. ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

* Free flyer accommodation is an alternate mode, and if used will require re-evaluation of all requirements

1. and 5. above - assume station operations
3. Periodic calibration and monitoring

TOTAL EVA HRS 0

Code: GDCD 0261

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: High Resolution Doppler Imager (HRDI)

Reference Documents:

1. Space Station NAAO Study, 14-15 September 1982 Orientation Meeting Handout at NASA Headquarters.

2. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982.

Narrative:

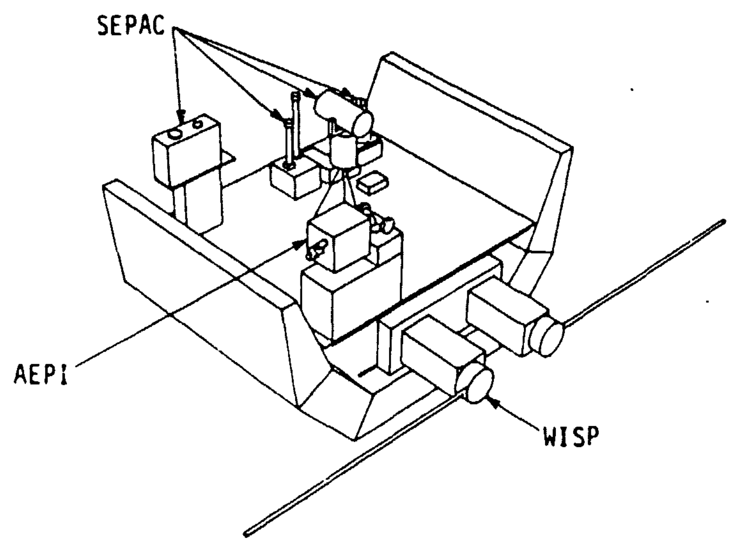
Payload element objectives and measurement characteristics were stated in Ref 1, p 8-26.

This payload is one of a number of remote sensing instruments proposed for the MSFC SASP. The physical characteristics were taken directly from Ref 2, p D-51.

After undergoing on-orbit development test for a year, the instrument is integrated into the Upper Atmosphere Research instrument group. Similar instruments are also incorporated into the Solar Terrestrial Observatory.

During developmental testing, manned interaction and access for servicing is beneficial. When mature, the instrument can be remotely operated with periodic servicing.

Launch date and mission duration were derived.



Space Plasma Physics Group

266.592-442

PAYLOAD ELEMENT SYNTHESIS

Example: High Resolution Doppler Imager (HRDI)

Measurements: Doppler shift in visible emissions on the limb

Objectives: Direct measurement of middle atmosphere winds

Special needs: Pointing stability and knowledge: 0.03 deg control, 0.002 deg/100 sec stability, 0.025 deg yaw knowledge

Impacts: Spacecraft design and operations

Solution: Stable platform

DESCRIPTION:

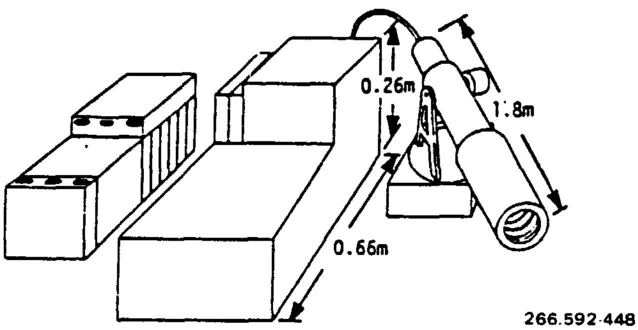
HRDI is an imaging triple etalon Fabry-Perot interferometer fed by a two axis gimbaled telescope. It observes absorption features of O_2 and bands in the scattered light in the 10-50 km altitude range and atmospheric emission features in the 60-300 km altitude range. Velocity broadening and doppler-shift measured. Both-side viewing desired. Desired wind measurement accuracy is 5m/sec.

EMISSIONS/SUSCEPTIBILITIES:

Sensitive to emission or absorption in lines measured, and to deposition on optics.

OPERATIONAL REQUIREMENTS:

HRDI operates in daylight only. Observations are made of the earth's limb at azimuth angles of 45 and 135 degrees with respect to the veolcity vector. Measurement of one wind component requires one scan (20 sec), one side viewing. Measurement of two wind components requires two scans spaced 136 seconds apart, one side viewing.



High Resolution Doppler

ORIGINAL PAGE IS
OF POOR QUALITY

PAYLOAD ELEMENT NAME
Meas of Air Pollution From SAT

CODE
G D C D 0 2 6 2

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 365

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 3

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 6

OBJECTIVE

To provide technology base for the development of passive remote sensors of atmospheric trace gases. (MAPS)

DESCRIPTION

For the MAPS payload modular instruments which would allow changing of components would be flown. Various tests to determine such things as optimum bandpasses, filtering and scanning could be performed for different instrument concepts and target gases. The equipment consists typically of camera, optical unit, tape recorder, electronics and cold plate.

CODE G D C D 0 2 6 2

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 200 - 200
Inclination, deg 57 Tolerance + 33 - 28.5
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec 7200 Field of view, deg ±40 Nadir Total
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	200	
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 4600 Downlink Frequency (MHZ) ____

CODE G D C D 0 2 6 2

THERMAL

[X] Active [X] Passive

Temperature, deg C operational min 15 max 45

non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____

non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: [ ] Internal [X] External [ ] Remote

Equipment ID/Function [ ] Pressurized [ ] Unpressurized

L,m 1.0	W,m 1.0	H,m 0.6	Stowed
L,m 1.0	W,m 1.0	H,m 0.6	Deployed

Launch mass, kg 100

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 1

Task Assignment Monitor Instruments

Skills (See Table B)

SKILL	5					
LEVEL	2					
Hrs/Day	0.2					

EVA [X] YES [ ] NO Reason Service/Reconfiguration Hrs/EVA 6

SERVICING/MAINTENANCE

SERVICE: Interval, days 90 Consumables, kg ____

Returnables, kg ____ Man Hours 2

CONFIGURATION CHANGES: Interval, day 90 Man/Hrs Req. 2

Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

(This payload could benefit commercial payload GDCD 1001.)

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0262 ELEMENT NAME MEASUREMENT OF AIR POLLUTION

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1990 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 90 DAYS TOTAL SERVICES 3

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE 1

☐ NOT APPLICABLE ____ EVA HRS PER SERVICE 1

EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.2 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 90 DAYS TOTAL RECONFIGS. 3

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 1

☐ NOT APPLICABLE EVA HRS PER RECONFIG. 1

EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

DATE(S) 1991 INT. HRS. ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Station OPS
2. Equipment servicing
3. Monitor instruments
4. Assume equipment changeout (filters, sensors, etc.)
5. Station OPS

TOTAL EVA HRS 6

Code: GDCD 0262

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Measurement of Air Pollution from Satellites (MAPS)

Reference Documents:

1. Space Station NAAO Study, 14-15 September 1982 Orientation Meeting Handout at NASA Headquarters, Attachment A, p 47.

2. Strawman Payload Data for Science and Applications Space Platforms, Final Report, SP80-MSFC-2403, January 1980.

Narrative:

This payload element was suggested as a Technology Development Mission in Attachement A to Ref 1.

An instrument with similar objectives and capabilities was developed for Shuttle flights and proposed for use on the MSFC SASP. The instrument is dexcribed in Ref 2, p 116.

For Space Station, an instrument with similar size characteristics could be used, but the film camera would be replaced by an electronic imaging instrument. The weight and power estimates from Ref 1 were used, rather than Ref 2.

Altitude and inclination are not critical for development testing, but most useful data would be obtained in high inclination orbits.

A mature version of this instrument could be used for air pollution detection and tracking per GDCD-1001.

Launch date and mission duration were derived.

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title:
Earth Observations Instrument Development

Langley Contact:
H. G. Reichle, Jr.

Experiment Title:
MAPS (Measurement of Air Pollution from Satellites)

Mission Objectives:
To provide technology base for the development of passive remote sensor of atmospheric trace gases

Mission Description:
Modular instruments which would allow changing of components would be flown. Various tests to determine such things as optimum bandpasses, flitering, and scanning could be performed for different instrument concepts and target gases.

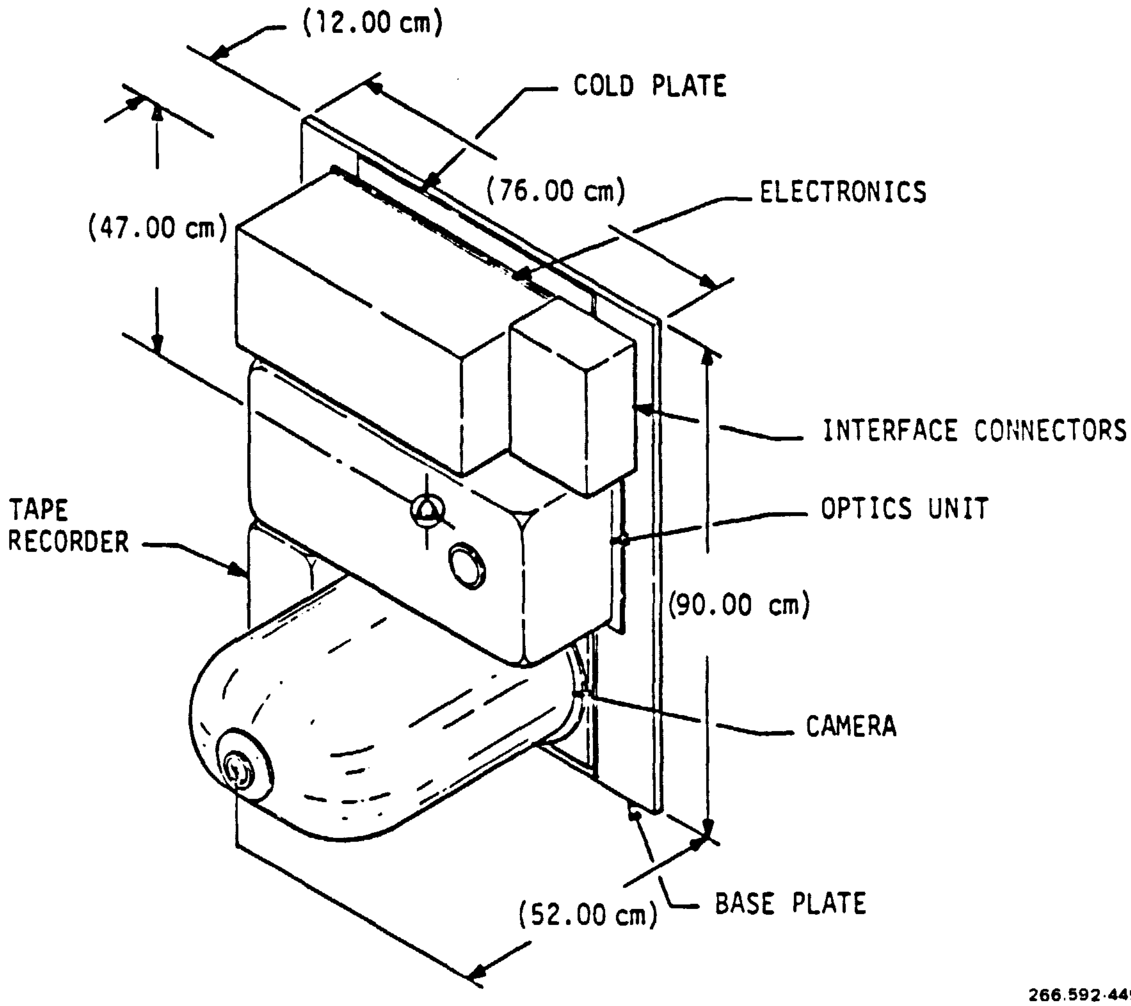
Benefit:
Current test methods involve the use of Shuttle sortie missions for techniques development. Lead times for integration are long and available missions are very few in number causing development to be very slow. Accelerated development would allow much earlier global trace gas assessments.

Justification:
Need space environment. Wide geographical coverage affording a variety of atmospheric conditions. Ability to make instrument adjustments on orbit to optimize test results.

Mission Requirements and Capability:
Altitude and inclination not critical. Must be Earth viewing attitude (Nadir $\pm 5^{\circ}$). Weights generally of order 100 kg, power of order 200 watts. Instrument thermal control required.

Space Station vs. Free Flyer:
Free flyer would suffer all disadvantages of sortie mission but to an even greater degree. Free flyer would not allow easy on orbit instrument modifications, hence is not a viable alternative.

Code: GDCD 0262 PAYLOAD ELEMENT SYNTHESIS



266.592-449

PAYLOAD ELEMENT NAME
CO2 Lidar For ATMOS Gas Meas

CODE G D C D 0 2 6 3

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1998
No. of flights 1
Duration of Flight, days 1825

TYPE
- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 3

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 6

OBJECTIVE

To provide technology for high pulse energy and high repetition rate CO_2 lasers with high frequency stability, wide tuning range, and long laser lifetimes.

DESCRIPTION

This CO_2 LIDAR for atmospheric trace gas concentration and wind velocity transport measurements payload will demonstrate the use of a high power CO_2 LIDAR from the Space Station for global environmental atmospheric studies, and for improved weather predictions.

CODE GDCD0263

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 100 - 100
Inclination, deg 57 Tolerance + 33 - 28.5
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec 3600 Field of view, deg Nadir/Limb
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	25,000	
Standby		
Peak		

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 250 Downlink Frequency (MHZ) ______

CODE G D C D 0 2 6 3

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ____ max ____
non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 9 W,m 4.5 H,m 4.5 Stowed
L,m 9 W,m 4.5 H,m 4.5 Deployed

Launch mass, kg 4000

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 1 Task Assignment Operate/Coordinate with GND

Skills (See Table B)

SKILL	3					
LEVEL	2					
Hrs/Day	0.25					

EVA ☒ YES ☐ NO Reason Service/Reconfig Hrs/EVA 50

SERVICING/MAINTENANCE

SERVICE: Interval, days 180 Consumables, kg ____
Returnables, kg ____ Man Hours 4

CONFIGURATION CHANGES: Interval, day 365 Man/Hrs Req. 16
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0263 ELEMENT NAME CO_2 LIDAR FOR ATMOS GAS MEAS

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1998 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 180 DAYS TOTAL SERVICES 9

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE 2

   ☐ NOT APPLICABLE ____ EVA HRS PER SERVICE 2

   EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.25 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL 365 DAYS TOTAL RECONFIGS. 4

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 8

   ☐ NOT APPLICABLE EVA HRS PER RECONFIG. 8

   EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

   DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Station OPS
2. Assume routine servicing
3. Operate
4. Assume equipment change
5. Operations continue after year 2000

TOTAL EVA HRS 50

Code: GDCD 0263

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: CO_2 LIDAR for Atmospheric Trace Gas Concentration & Wind Velocity/Transport Measurements

Reference Documents:

1. Space Station NAAO Study, 14-15 September 1982 Orientation Meeting Handout at NASA Headquarters, Attachment A, P 48.

2. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982.

Narrative:

This payload element was suggested as a Technology Development mission in Attachment A to Ref 1 p 12-75. The referenced power input of 25 kW was used.

The physical characters were derived by GDC by scaling-up to LIDAR facility described in Ref 2, p D-83.

This large CO_2 LIDAR facility is conceived as a 3-pallet train which holds the telescope, pointing mount, electronics and cooling system equipment. The pallet train is berthed to a standard port which furnishes power, cooling fluid and data bus interfaces.

Manned access is required periodically for servicing and for changing lasers and detectors.

Developmental testing can be carried out at 28.5 degrees inclination, but global weather studies require at least 57 degree orbit.

Launch date and mission duration were derived.

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title:
Earth Observations Instrument Development

Langley Contact:
R.V. Hess

Experiment Title:
CO_2 Lidar for Atmospheric Trace Gas Concentration and Wind Velocity/Transport Measurements

Mission Objective:
To provide the technology for high pulse energy and high repetition CO_2 lasers with high frequency stability and wide tuning range and longer laser life times

Mission Description:
The mission will provide the technology for the mission objectives. Key issues are establishment of the laser characteristics in the space station environment with benefits from the manned technology laboratory

Benefit:
The availability of higher power than on the Shuttle will provide vital information for environmental atmospheric studies and for meteorology for improved weather predicition for civilian and military purposes.

Justification:
Demonstration of CO_2 Lidar from the space station with availability of high powers, is of great importance for global environmental and meterological studies, which cannot be conducted from the ground. The experiment could also be applied to evaluation of rendezvous with non-cooperative targets

Mission Requirements and Capability:
Power requirements of 25 kw and higher

Space Station vs. Free Flyer:
Applicability of experiment to free flyer will be determined by demonstration

ORIGINAL PAGE IS
OF POOR QUALITY

PAYLOAD ELEMENT NAME
LIDAR Facility

CODE G D C D 0 2 6 4

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1992
No. of flights 1
Duration of Flight, days 365

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 3

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

OBJECTIVE

Profiling the abundance of atomic molecular species and aerosols; collecting meteorological data (wind velocity, cloud height, temperature and pressure profiles).

DESCRIPTION

The LIDAR is integrated on a spacelab type of pallet which is docked to the host platform or station. (Later to become part of Solar Terrestrial Observatory (STO) GDCD 0244 and GDCD 0246.)

CODE GDCD0264

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 100 - 100
Inclination, deg 57 Tolerance + 33 - 0
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec 3600 Field of view, deg Nadir
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	4500	
Standby		
Peak		

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 253 Downlink Frequency (MHZ) ______

CODE G D C D 0 2 6 4

THERMAL

[X] Active [X] Passive (Self-Contained)

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: [ ] Internal [X] External [ ] Remote

Equipment ID/Function [ ] Pressurized [ ] Unpressurized

L,m 4.5 W,m 4.5 H,m 4.5 Stowed
L,m 4.5 W,m 4.5 H,m 4.5 Deployed

Launch mass, kg 1900

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1

Skills (See Table B)

	Task Assignment		Operate/Measure Response			
SKILL	5					
LEVEL	2					
Hrs/Day	0.2					

EVA [X] YES [ ] NO Reason Service Hrs/EVA 10

SERVICING/MAINTENANCE

SERVICE: Interval, days 180 Consumables, kg ______
Returnables, kg ______ Man Hours 4

CONFIGURATION CHANGES: Interval, day 180 Man/Hrs Req. 16
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

GDCD CODE 0264 ELEMENT NAME LIDAR FACILITY

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER* ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1992 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 180 DAYS TOTAL SERVICES 1

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE 2

☐ NOT APPLICABLE ____ EVA HRS PER SERVICE 2

EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.2 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 180 DAYS TOTAL RECONFIGS. 1

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 8

☐ NOT APPLICABLE EVA HRS PER RECONFIG. 8

EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

DATE(S) 1993 INT. HRS. ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

* Free flyer accommodation is an alternate mode and if used will require re-evaluation of all requirements.

1. Station OPS
2. Routine servicing
3. Operate and measure response
4. Updating equipment
5. Assume Station OPS

TOTAL EVA HRS 10

Code: GDCD 0264

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: LIDAR Facility

Reference Documents:

1. Space Station NAAO Study, 14-15 September 1982 Orientation Meeting Handout at NASA Headquarters.

2. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982.

Narrative:

This payload element is listed as a major proposed mission in development in Ref 1, P 8-20. Examples of the mission objectives and measurement description are given in Ref 1, P 8-30.

The LIDAR facility proposed for the MSFC SASP was chosen as representative of the required mission equipment. The physical characteristics of the payload element were taken directly from Ref 2, P D-83.

The LIDAR and its support equipment are installed on a pallet which berths to a standard docking port. Manned access is required for servicing and updating.

A high inclination (57-90 degrees) orbit is desired tc obtain global meteorological coverage.

The LIDAR later is integrated into the Solar Terrestrial Observatory.

Launch data and mission duration were derived by GDC.

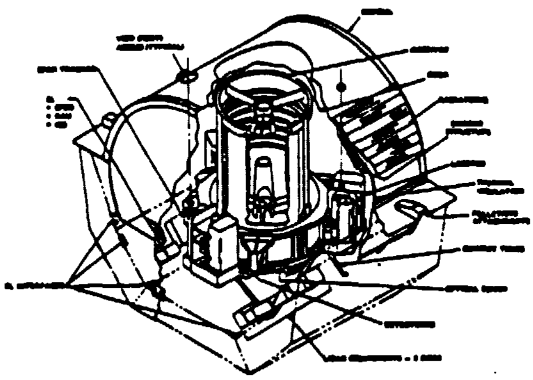
Code: GDCD 0264

PAYLOAD ELEMENT SYNTHESIS

Example: LIDAR

Measurement:	Atmospheric response to laser radiation
Objectives:	Sound for winds and chemical composition of the atmosphere
Special needs:	3.5 kW Power, long life laser, clean optics, global coverage, 2000 kg
Impacts:	Orbit, structure, contamination
Solution:	Polar orbit, large spacecraft

Light Detection and Ranging Facility (LIDAR)



DESCRIPTION

MASS UP/DOWN (kg): 1900/1900
SIZE (m): Dedicated SL Pallet
POWER OP./PK.(kW): 4.5
HEAT REJECTION: Active/Passive
DATA SCI./STAT.(kbps): 253/TBD
POINTING TYPE: Nadir
ACC.(deg)/STAB.(min): 1/6
OPERATING COND: TBD
ORBIT (km/deg): 300/57
FLIGHT DURATION (mo.): TBD

DESCRIPTION: LIDAR is a modular multiuser facility consisting of several elements: (1) Laser sources - Nd: Yag, Dye system, CO_2; detection packages; 1.25 meter class telescope; and controlling electronics. LIDAR will occupy a full pallet. Science objectives include profiling the abundance of atomic and molecular species and aerosols and collecting meteorological data (wind velocity, cloud height, temperature and pressure profiles). Pointing direction is mostly nadir.

EMISSIONS/SUSCEPTIBILITIES: Laser output is in the 0.2 - 12.0 μm spectral range. LIDAR would be sensitive to the standard range of optical contaminants effective in this spectral range. Dye laser (215-940 nm) puts out 5 - 200 μJ pulses at a repetition rate of 10 Hz. CO_2 laser puts out 10 J pulses at a 15 Hz repetition frequency.

OPERATIONAL REQUIREMENTS: Meaningful data may be taken over the 24-hour day. Some observations of particular target zones may be desired.

SPECIAL CONSIDERATIONS: Radiator requires view to space/sun avoidance.

NASA STO CONTACT: Bill Roberts, MSFC

REFERENCE: Solar Terrestrial Observatory Conceptual Design and Analysis Study, March 1982

266.592.450

Light Detection & Ranging Facility (LIDAR)

PAYLOAD ELEMENT NAME
Upper Atmosphere Res Pl - Dev

CODE GDCD0265

TYPE
- [x] Science & Applications (non-commercial)
- [ ] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A): 3

CONTACT
Name / Address: W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone: (619) 277-8900, Ext. 3778/2130

STATUS
- [ ] Operational
- [ ] Approved
- [ ] Planned
- [x] Candidate
- [ ] Opportunity

First flight, yr: 1994
No. of flights: 1
Duration of Flight, days: 550

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10: 9

OBJECTIVE

Measure atmosphere composition temperature, pressure, wind velocity, solar irradiance, etc.

DESCRIPTION A special carrier structure would be utilized to satisfy the viewing requirements of the following instrument group and optimize the utilization of the envelope: ATMOS-atmospheric trace molecular spectrometer, HALOE-Halogen ocultation Exp, TWM-Temp wind measurement in atmosphere and lower thermosphere, CLAES-cryogenic limb array Etalon spectrometer, ISAMS-Improved stratosphereic and mesopheric sounder, MSL-microwave limb irradiance sounder, HRDI-high resolution doppler imager, USSIE, UV solar spectral irradiance EXP, SUSIM-solar UV spectral irradiance monitor.

CODE G D C D 0 2 6 5

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 200 - 0
Inclination, deg 57 Tolerance + 33 - 28.5
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☒ Solar ☒ Earth
Truth Sites (if known) ____ ±45 Nadir - Also Limb
Pointing accuracy, arc sec 36 Field of view, deg 60°-90° EL, 0°-360° AZ
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	4000	12
Standby	2000	12
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 500 Downlink Frequency (MHZ) ____

CODE G D C D 0 2 6 5

THERMAL

☒ Active ☒ Passive Fluid Loop

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min 825 max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 4.5 W,m 4.5 H,m 2 Stowed

L,m 4.5 W,m 4.5 H,m 2 Deployed

Launch mass, kg 2500

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2 Task Assignment Calibration/Alignment

Skills (See Table B)

SKILL	4	5				
LEVEL	3	2				
Hrs/Day	0.4	0.4				

EVA ☒ YES ☐ NO Reason Service; Cryogens Hrs/EVA 18

SERVICING/MAINTENANCE

SERVICE: Interval, days 225 Consumables, kg ______
Returnables, kg ______ Man Hours 6

CONFIGURATION CHANGES: Interval, day 225 Man/Hrs Req. 24
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions EMISSIONS/SUSCEPTIBILITIES: Cryogen system on CLAES vents hydrogen. The payload is sensitive to absorption, emission, or scattering through the spectrum & UV through IR), deposition on optics, and microwave interference to (HLS). OPERATIONAL CONSIDERATIONS: HALOE operates at dawn/dusk. The remaining instruments all operate on the day side of the orbit and some also operate on the night side. Solar observations are required at least once per day by SUSIM and USSIE. USSIE also requires occasional observations of stars for calibration. The atmosphere viewing instruments require global coverage as continuously as possible.

GDCD CODE 0265 ELEMENT NAME UPPER ATMOS. RES. PAYLOAD DEVELOPMENT

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1994 INT. HRS ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 225 DAYS TOTAL SERVICES 1

   ☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE 6

   ☐ NOT APPLICABLE ______ EVA HRS PER SERVICE 6

   EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.8 HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL 225 DAYS TOTAL RECONFIGS. 1

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 12

   ☐ NOT APPLICABLE EVA HRS PER RECONFIG. 12

   EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

   DATE(S) 1996 INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Station OPS
2. Replace cryogenics
3. 2 crew @ 0.4 hrs. each
4. Assume equipment update
5. Station OPS

TOTAL EVA HRS 18

Code: GDCD 0265

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Upper Atmosphere Research Payload - Development

Reference Documents:

1. Space Station NAAO Study, 14-15 September 1982 Orientation Meeting Handout at NASA Headquarters.

2. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations Study, SP82-MSFC-2583, March 1982.

Narrative:

This mission is listed as a major proposed mission in Ref 1, P 8-20. Status of the UAR satellite is given on pp 8-9 of Ref 1. The satellite is proposed for launch in 1988.

A group of experiments (UARS E) with similar objectives and measurement requirements is given in Ref 1, pp 8-23.

The group of instruments was further defined for accommodation on the MSFC SASP. The instruments, mounting structure and integration hardware are described in Ref, 2 p D-46. This payload element description was taken directly from this latter reference, although the actual instruments would be 2nd generation models.

The instrument group is flown on a manned space station for a one year development period where manned access is required for adjustments, servicing, and interchanging detectors and other active elements.

The instruments are later flown operationally on a high inclination orbiting platform or space station.

Launch schedule and mission duration were derived.

Upper Atmosphere Research Satellite (UARS) Status

Objective:	Obtain integrated global measurements of upper atmosphere composition, dynamics, and energy input
Recommended By:	Space science board Committee on solar terrestrial relationships
Study Phase	Scientific working group October 1977 - July 1978
Ad Released:	September 15, 1978
Preliminary Selection:	April 1980 (16 experimental & 10 theoretical investigations)
Phase B Instrument Studies:	May 1980 - November 1981
Final Selection:	November 1981 (9 experimental & 10 theoretical investigations)
Start:	Experiments and mission studies: FY1982 Spacecraft and ground segments: FY1984 candidate
Launch:	Fall 1988
Center:	Goddard Space Flight Center
Configuration:	One spacecraft in 600 km, 57 degree orbit, 18-month lifetime

Measurements: Visible, infrared, ultraviolet, and microwave observations of the Earth's limb, UV Nadir sounding for ozone, UV solar and stellar observations.

Objectives: Understand the coupling of dynamics, energetics and composition of the stratosphere

Special Needs: Simultaneous viewing of Nadir, both limbs, sun, and limb 45 degrees of satellite, massive payload (2000KG), solid hydrogen cryogen (10 K), global coverage at limb

Impacts: One instrument lifetime limited (18 months), orbits of roughly 70 degree inclination, satellite size

Solution: Unique free flyer

Code: GDCD 0265

PAYLOAD ELEMENT SYNTHESIS

DESCRIPTION

Payload contains UARS instrument group (HALOE, TWM, CLAES, ISAMS, MLS, HRDI, USSIE, AND SUSIM) plus integration hardware. It is anticipated that a special carrier structure would be utilized which would satisfy the viewing requirements of the instrument group and optimize utilization of the Orbiter cargo envelope.

ORBIT CHARACTERISTICS

Altitude (km):	400
Inclination (deg):	57

Other requirements:

EMISSIONS/SUSCEPTIBILITIES

Cryogen system on CLAES vents hydrogen. The payload is sensitive to absorption, emission, or scattering through the spectrum (UV through IR), deposition on optics, and microwave interference to (MLS).

VIEWING REQUIREMENTS

The payload requires viewing in multiple directions: solar, solar occultation, stars, earth limb cross track (one side and both sides), and earth's limb at 45 and 135 degrees from the velocity vector on one side.

OPERATIONAL CONSIDERATIONS

HALOE operates at dawn/dusk. The remaining instruments all operate on the day side of the orbit and some also operate on the night side. Solar observations are required at least once per day by SUSIM and USSIE. USSIE also requires occassional observations of stars for calibration. The atmosphere viewing instruments require global coverage as continuously as possible.

STS INTERFACES

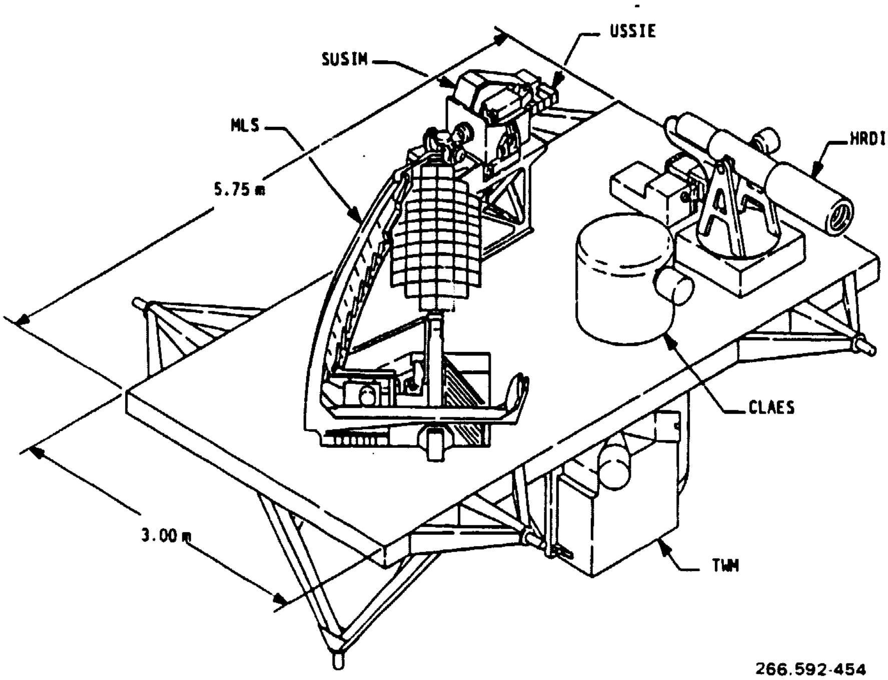
Cryogenic system on CLAES may require monitering for safety.

266.592.452

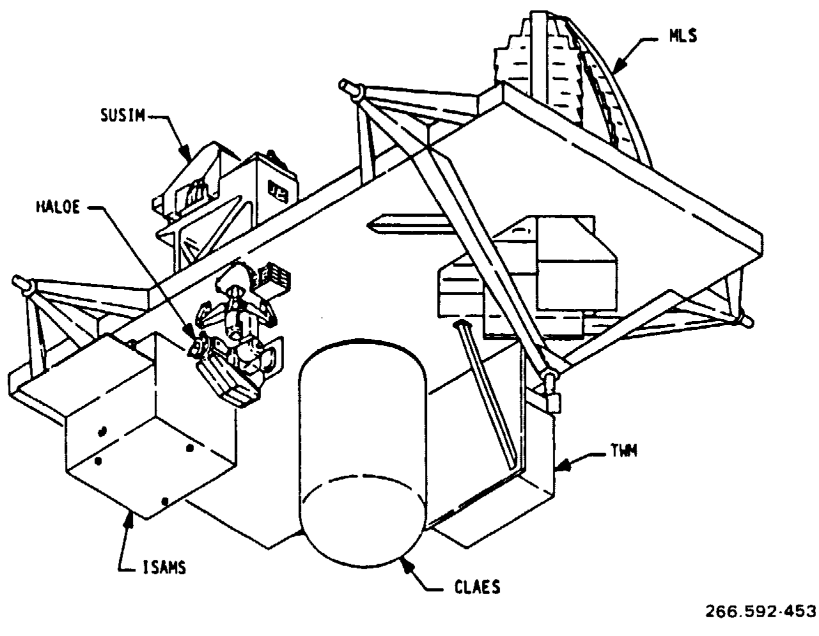
Payload for Upper Atmosphere Research Satellite (UARS)

Upper Atmosphere Research Project

HALOE	Halogen Occultation Experiment Limb - Solar occultation - 2 axis gimbal.
TWM	Temperature and Wind Measurement in the Mesosphere and Lower Thermosphere Limb
CLAES	Cryogenic Limb Array Etalon Spectometer (Limb pointing)
ISAMS	Improved Stratospheric and Mesospheric Sounder Limb scanning
MLS	Microwave Limb Sounder Limb
HRDI	High Resolution Doppler Imager Limb - 2 axis glimbal
USSIE	Ultraviolet Solar Spectral Irradiance Experiment Solar pointing - mount on pointing platform
SUSIM	Solar Ultraviolet Spectral Irradiance Monitor Solar pointing - mount on pointing platform



Upper Instruments



Lower Instruments

ITEM	MASS (kg) UP/DOWN	POWER (W) OP./PEAK	ATC (W)	DATA (kbps)		
				SCI	STATUS	CMD
SCIENCE INSTRUMENTS:						
HALOE	96	65/96	Passive	4.0	TBD	(0.5)*
TWM	65	47/TBD	Passive	1.1	TBD	
CLAES	450/430	20/TBD	Passive	3.0	TBD	
ISAMS	85	125/TBD	Passive	0.6	TBD	
MLS	234	470/TBD	(400)	4.1	TBD	
HRDI	76	82/TBD	Passive	4.0	TBD	
USSIE	8	5/TBD	Passive	0.064	TBD	
SUSIM	94	100/TBD	Passive	1.0	TBD	
INTEGRATION HARDWARE:						
Signal Interface Unit (2)	20	50	50	-	TBD	TBD
Power Interface Unit (1)	40	50	50	-	TBD	TBD
Freon Pump Package	63	325	325	-	TBD	TBD
S/S Coldplate	14					
Experiment Coldplate (1)	22					
CARRIER:						
Special Carrier	1000					
Berthing Adapter Assembly	100					
PAYLOAD TOTALS	2367/2347	1339/TBD	(825)	18	(2)	(0.6)

* in CMD column indicates ancillary data

( ) TBE estimate

266.592-455

Table of UARS Payload Characteristics

PAYLOAD ELEMENT NAME
WINDSAT

CODE GDCD0266

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- [ ] Operational
- [ ] Approved
- [ ] Planned
- [x] Candidate
- [ ] Opportunity

First flight, yr 1995
No. of flights 1
Duration of Flight, days 3285

TYPE
- [x] Science & Applications (non-commercial)
- [ ] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A) 3

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 7

OBJECTIVE

Measure wind vector profiles using doppler Lidar, to allow accurate world-wide forecast to be made 5 days in advance.

DESCRIPTION

WINDSAT is a dedicated, free-flying spacecraft that carries a doppler Lidar wind measurement system. Global coverage is required.

CODE
G D C D 0 2 6 6

ORBIT CHARACTERISTICS
Apogee, km 800 Perigee, km 800 Tolerance + -
Inclination, deg 98 Tolerance + -
Nodal Angle, deg (Sun Synch) Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known)
Pointing accuracy, arc sec 1026 Field of view, deg
Pointing Stability (Jitter) arc sec/sec
Special Restrictions (Avoidance)

POWER
☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	200	(Service Only)
Standby		
Peak		

☐ Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) Frequency (MHZ)
☐ On-Board Data Processing Required
Description

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day
Film (Amount) Voice (Hrs/Day)
Live TV (Hrs/Day) Other
On-Board Storage (MBIT)
Data Dump Frequency (Per Orbit)
Recording Rate (KBPS) Downlink Frequency (MHZ)

CODE G D C D 0 2 6 6

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☒ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 4.5	W,m 4.5	H,m 4.5	Stowed
L,m 4.5	W,m 4.5	H,m 4.5	Deployed

Launch mass, kg 2260

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days 730 Consumables, kg ______
Returnables, kg ______ Man Hours 16

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0266 ELEMENT NAME WINDSAT

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1995 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 730 DAYS TOTAL SERVICES 3

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE 16

   ☐ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ____ HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Station OPS
2. Resupply cryogenics
5. Operation continues after year 2000

TOTAL EVA HRS 0

Code: GDCD 0266

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: WINDSAT

Reference Documents:

1. Space Station NAAO Study, 14 & 15 September 1982 Orientation Meeting Handout at NASA Headquarters

2. NASA TM 82435, "Accommodation Assessment - Spaceborne Doppler Lidar-Wind Measuring System", August 1981.

Narrative:

This mission is listed as a major proposed initiative in Ref 1, pp 8-20. The mission objectives and measurement needs are listed in Ref 1, pp 8-12.

Conceptual studies of the doppler LIDAR system and the total spacecraft have been performed by LMSC and MSFC, respectively. The physical characteristics of the WINDSAT used in this payload element description were taken directly from Ref 2.

The 800 km, sun synchronous orbit requirement dictates that this be a free-flyer mission. Servicing/updating at 2-year intervals is envisioned. Since the spacecraft described has no propulsion subsystem, it is a candidate for TMS emplacement and retrieval. Alternatively, it could be redesigned to be supported by a Leasecraft bus with self-contained propulsion.

The launch schedule and mission duration were derived by GDC, based on a 4-year development program following a 1988 new start (Ref 1).

WINDSAT

Objective:	Measure wind vector profiles using doppler lidar
Measurement Needs:	Global coverage for one year plus 1 km vertical resolution to >15 km altitude 1 M/S accuracy in wind speed
Study Phase:	NASA and NOAA feasibility studies completed 1982
Start:	1988 new start

PAYLOAD ELEMENT NAME
Upper Atmosphere Res Pl - OPRN

CODE GDCD0267

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1994
No. of flights 1
Duration of Flight, days 1460

OBJECTIVE

Measure atmosphere composition temperature, pressure, wind velocity, solar irradiance, etc. (This is the operational version of the "development" payload described in GDCD 0265.)

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number 3
(see Table A)

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

DESCRIPTION A free-flyer structure (satellite) would be utilized to satisfy the viewing requirements of the following instrument group and optimize the utilization of the envelope: ATMOS-atmospheric trace molecular spectrometer, HALOE-Halogen ocultation Exp, TWM-temp wind measurement at atmosphere and lower thermosphere, CLAES-cryogenic Limb array Etalon sepctrometer, ISAMS-improved stratospheric and mesospheric sounder, MSL-microwave limb sounder, HRDI-high resolution doppler imager, USSIE, UV solar spectral irradiance Exp, SUSIM-solar UV spectral irradiance monitor.

CODE G D C D 0 2 6 7

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 200 - 0
Inclination, deg 57 Tolerance + 33 - 0
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☒ Solar ☒ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec 36 Field of view, deg ±45 Nadir - Also Limb 60°-90° EL, 0°-360° AZ
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	4000	12
Standby	2000	12
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 500 Downlink Frequency (MHZ) ____

ORIGINAL PAGE IS
OF POOR QUALITY

CODE G D C D 0 2 6 7 Page 3 of 3

THERMAL

[X] Active [X] Passive Fluid Loop

Temperature, deg C operational min ____ max ____

non-operational min ____ max ____

Heat Rejection, w operational min 825 max ____

non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: [ ] Internal [ ] External [ ] Remote

Equipment ID/Function [ ] Pressurized [ ] Unpressurized

L,m 4.5 W,m 4.5 H,m 2 Stowed

L,m 4.5 W,m 4.5 H,m 2 Deployed

Launch mass, kg 2500

Consumables Types Cryogenics

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size ____ Task Assignment ____

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA [ ] YES [X] NO Reason ____ Hrs/EVA ____

SERVICING/MAINTENANCE

SERVICE: Interval, days 600 Consumables, kg ____

Returnables, kg ____ Man Hours 16

CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____

Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions EMISSIONS/SUSCEPTIBILITIES: Cryogen system on CLAES vents hydrogen. The payload is sensitive to absorption, emission, or scattering through the spectrum (UV through IR), deposition on optics, and microwave interference to (HLS). OPERATIONAL CONSIDERATIONS: HALOE operates at dawn/dusk. The remaining instruments all operate on the day side of the orbit and some also operate on the night side. Solar observations are required at least once per day by SUSIM and USSIE. USSIE also requires occasional observations of stars for calibration. The atmosphere viewing instruments require global coverage as continuously as possible.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0267 ELEMENT NAME UPPER ATMOS INST. RES P/L-OPERATIONAL

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1994 INT. HRS ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 600 DAYS TOTAL SERVICES 1

   ☒ TMS/OTV REQUIRED ALTERNATE — STATION HRS PER SERVICE 16

   ☐ NOT APPLICABLE — EVA HRS PER SERVICE ______

   EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ______ HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ______ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED — STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE — EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) 1998 INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

This payload element assumes accommodation on a platform or Leasecraft type spacecraft which has orbit transfer propulsion.

1. Station OPS
2. Cryogenics resupply
5. Assume Station OPs

TOTAL EVA HRS 0

Code: GDCD 0267

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Upper Atmosphere Research Payload - Operational

Reference Documents:

1. Space Station NAAO Study, 14-15 September 1982 Orientation Meeting Handout at NASA Headquarters

2. Space Platform Payload Data, Science and Application Space Platform Payload Accommodations SStudy, SP82-MSFC-2583, March 1982.

Narrative:

This is an operational version of GDCD-0265.

Following a 1-year development flight on a manned space station, the instrument group is flown on a high inclination orbit platform or manned space station. The weight is for instrument package only; a Leasecraft type spacecraft would be required to provide orbit transfer propulsion, and support resources.

Manned presence would be desireable, but the instruments could be remotely operated with periodic manned servicing. The CLAES would require expanded capacity of its cryogenic cooling supply to extend its operating time from 18 to 24 months.

The launch schedule, servicing intervals and mission duration were derived by GDC.

Section 1.4

Discipline Life Sciences

GDCD ID NO.	PAYLOAD ELEMENT NAME
	BIOLOGICAL SCIENCE
0300	Human Research Laboratory
0301	Animal and Plant Research Laboratory
	OPERATIONAL MEDICINE
0322	EVA Performance and Productivity
	LIFE SUPPORT
0340	$H_2O/O_2/CO_2/N_2$ Regenerative Systems
0341	CELSS Experimental Systems
0342	Dedicated CLSS Module
0343	CELSS Pallet

PAYLOAD ELEMENT NAME
Human Research Laboratory

CODE G D C D 0 3 0 0

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☒ Planned
- ☐ Candidate
- ☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 3600

OBJECTIVE Provide a research laboratory for experiments in human performance, medical care technology, bone/calcium metabolism, lean body metabolism, cardiovascular and pulminary physiology, endodrinology, hematology, immunology, and radiation effects, to address operational medical problems and to elucidate basic mechanisms of adaptation to spaceflight.

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 4

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

DESCRIPTION
Press module containing instr, equip, and supplies to support human physiological, psychological, and clinical technology research in: 1) human perf assessment, incl psychomotor, neurosensory, vestibular research: 2) medical care tech, incl 0g verif of surgical and orthopedic procedures (see 0301) new equip; 3) bone/calcium metaabolism, incl on-board blood, urine, fecal analysis, noninvasive bone density mineral analysis, bone biopsy instr; 4) lean body metabolism, incl balance studies, other dietary, biochemical hormonal studies; 5) cardiovasular/pulmonary physiology, incl CV stressordevices, noninvasive instr for monitor cardiac elect-mech behavior, respiratory gas monitor; 6) endocrinology, incl meas of homonal response to stress of space; 7) hematology/immunology, incl onboard analysis of blood constituents lymphatic system; 8) rad effects (see 0301) envir and personal rad monitor long term med statistical analyses..

CODE G D C D 0 3 0 0 — Page 2 of 3

ORBIT CHARACTERISTICS

Apogee, km: Any — Perigee, km: Any — Tolerance + ____ - ____
Inclination, deg: Any — Tolerance + ____ - ____
Nodal Angle, deg: ____ — Ephemeris Accuracy, m: ____
Escape dV Required, m/s: ____

POINTING/ORIENTATION

View direction: ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known): ____
Pointing accuracy, arc sec: ____ Field of view, deg: ____
Pointing Stability (Jitter) arc sec/sec: ____
Special Restrictions (Avoidance): ____

POWER

☒ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	2000	8
Standby		
Peak	3000	1

☒ Continuous

Voltage, V: ____ Frequency, Hz: ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☒ On-Board Data Processing Required

Description
128 KBPS to On-board Computer(s); 64 KBPS Downlink 1 Hr/Day

Data Types: ☐ Analog ☒ Digital ☒ Hrs/Day: 8
Film (Amount): ____ Voice (Hrs/Day): ____
Live TV (Hrs/Day): 1 Other: ____
On-Board Storage (MBIT): ____
Data Dump Frequency (Per Orbit): ____
Recording Rate (KBPS): 128 Downlink Frequency (MHZ): ____

CODE G D C D 0 3 0 0

THERMAL

☒ Active ☐ Passive

Temperature, deg C operational min 20 max 24
non-operational min ____ max ____

Heat Rejection, w operational min 1000 max 3000
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☒ Internal ☐ External ☐ Remote

Equipment ID/Function ☒ Pressurized ☐ Unpressurized

L,m 7.0 W,m 4.0 H,m 4.0 Stowed
L,m 7.0 W,m 4.0 H,m 4.0 Deployed

Launch mass, kg 7300

Consumables Types Med. Supplies, Reagents, O_2, H_2O

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 2 Task Assignment Human Physiological Research/ Human Subject

Skills (See Table B)

SKILL	2	2	2			
LEVEL	3	2	1			
Hrs/Day	4	4	2			

EVA ☐ YES ☒ NO Reason ____ Hrs/EVA ____

SERVICING/MAINTENANCE

SERVICE: Interval, days 90 Consumables, kg ____
Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day 720 Man/Hrs Req. 40
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Of the experiments performed over 10 years, 20 of these will include the human research payload as a primary emphasis and 20 will include human research as a secondary emphasis; crew time, power, and data shown here represents the primary emphasis mission in the early years; later years crew time increases to 16 m-hr/day total; heat projection is for payload elements only, Not module systems. Size includes module accommodation. Service crew time included in routine operations.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0300 ELEMENT NAME HUMAN RESEARCH LAB

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1994 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 90 DAYS TOTAL SERVICES 40

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☐ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

10 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 720 DAYS TOTAL RECONFIGS. 4

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 40

☐ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Station OPS
2. Assume time included under station operations
3. Operation of equipment + act as subject
4. Update of equipment
5. Payload continues operation after 2000

TOTAL EVA HRS 0

Code: GDCD 0300

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Human Research Library

Reference Documents:

1. Biomedical Results from Skylab; edited by R.S. Johnson and L.F. Dietlein, Scientific and Technical Information Office, NASA, Washington, DC, NASA SP-377, 1977

2. Operational Medicine Support to Long Duration Manned Missions in Low Earth Orbit and Beyond; edited by S. Furukawa, M.D., Operational Medicine Office, Life Sciences Division (EB-3) Space Science and Applications, NASA Headquarters, Washington, DC, February 1982

3. Foundations of Space Biology and Medicine, Volume III, Space Medicine and Biotechnology; edited by M. Calvin (USA) and O.G. Gazenko (USSR); Scientific and Technical Information Office, NASA, Washington, DC 1975. (Chapter 17, An Appraisal of Future Space Biomedical Research by S.P. Vinograd, NASA Washington, DC)

4. Space Station Needs, Attributes and Architectural Options; Contractor Orientation Meeting, September 14 & 15, 1982; Section 6, Life Science Concerns for Space Station, briefing by W.P. Bishop, 14 September 1982

5. Life Sciences Considerations for Space Station, Life Sciences Division (EB-3), Office of Space Science and Application, NASA, Washington, DC 20546. September 14, 1982

6. Life Sciences Research and the Science and Applications Space Platform, E.W. Gomersall, Coordinator, Biosystems Division, Ames Research Center, February 1982

7. Life Sciences Experiments for a Space Platform/Station; J.D. Fabricant, University of Texas, Medical Branch, Galveston Texas; Society of Automotive Engineers Technical Paper 820834, Twelfth Intersociety Conference on Environmental Systems, San Diego, July 1982

8. Life Sciences Mission Requirements Document (Draft) edited at Ames Research Center, November 1982

9. Life Sciences Flight Experiments Program, Mission Science Requirements Document for The First Life Sciences Dedicated Spacelab Mission (Parts I & II); J.A. Rummel, Johnson Space Center Report 18295, 1 June 1982.

10. Medical Operations and Life Sciences Activities on Space Stations; edited by P.C. Johnson and J.A. Mason, NASA TM 58248, Johnson Space Center, October 1982

11. Spacelab Mission 4, Mission Definition Study Report Summary; Study Manager, M.J. Harnage, Jr., Johnson Space Center, November 1982

12. Future Directions for the Life Sciences in NASA; A Report of the Life Sciences Advisory Committee of the NASA Advisory Council; edited by G.D. Whedon, Chairman, Life Sciences Advisory Committee, NASA, November 1979.

13. Life Beyond the Earth's Environment, The Biology of Living Organisms in Space, edited by N.S. BRicker and L.G. FIne, National Academy of Sciences, 1979

14. Life Sciences Laboratory Equipment (LSLE) Handbook, Johnson Space Center, 1981

15. Space Station User Fact Sheets and Contact Reports (attachments to letter to W. Hardy from R. Farrell, December 1982)

16. Life Sciences and Life Support Development Experiments on a Space Station, A.T. Skoog, Dornier System, GmbH, Document No. TN-SSS-DS-005, February 1983

Narrative:

This payload supports experiments concerning human physiological response, behavioral response and clinical technology pertinent to human adaption to space flight. Representative experiments are listed (Table 1); module weights and power are estimated.

Eight discipline groupings (payload, sub-elements) are listed, traceable to data in Ref 1 through 16 as will be described; see Figure 1. Groups 1 to 7 relate to space medical problems, group 8 relates to the development and validation of equipment and procedures to support operational medicine; e.g. altered drug responses, zero-g fluid handling, in flight surgical procedures. Long term human exposure to weightlessness of space heightens the need to obtain useful solutions to medical problems that have been encountered. Among these are: cardiovascular deconditioning, bone mineral loss, loss of lean body mass and muscle strength, decrease in red blood cell mass and nausea associated with space motion sickness. These results and others are described in the SKYLAB report, Ref 1, which summarizes biomedical test results of the last extensive space biomedical study done by the U.S.

Ref 2 contains a "Comprehensive List of NASA Life Science Concerns" (p I-A-1, therein) without attention to priorities. Similar material in summary form, is listed in Ref 3, 12 and 13. Ref 4 describes NASA's Life Science Program. The graph on page 6-8 therein shows on interpretation of effect of time in space on seven human physiologic changes discovered and/or extrapolated from results of past spaceflight; these seven groups are contained in the synthesis of Ref 1 to 3 and 5-10, which also describe some of the tasks/research for each group (e.g., see Ref 2). Space Station resources requirements for this payload element are derived from Ref 9, 11, and 14. Ref 5 to 10 also describe crew medical problems in space which can be traced to items listed in Ref 2, 12 and 13.

Table 1
Human Biomedical Research

1. Human Performance
   - psychomotor
   - neurosensory
   - vestibular

2. Bone/Calcium Metabolism
   - on-board blood, urine and fecal analyses
   - non-invasive bone density tests
   - bone biopsy
   - mineral analysis

3. Lean Body Metabolism
   - balance studies
   - dietary studies
   - biochemical and hormonal studies
   - muscle strength measurement

4. Cardiovascular/Pulmonary Physiology
   - cardiovascular stressing
   - cardial electrical/mechanical behavior
   - respiratory gas monitoring

5. Endocrinology
   - Hormonal stress responses
   - Fluid/Electrolyte balance

6. Hematology/Immunology
   Blood constituents
   lymphatic alterations

7. Radiation Effects (interactive with 0301 and Operational Medicine)
   environment
   crew radiation monitoring
   long term medical statistics

8. Medical Care Technology
   Zero gravity verification of surgical/orthopedic procedures (interactive with 0301)
   Fluid handling
   Pharmacological kinetic

Weight of the Human Research Lab payload is based on 7300 kg, derived from SPACELAB data in Ref 11 and 14 for a similar set of medical experimental equipment (assuming additional onboard analysis instrumentation replacing weight and power requirements of animal holding facilities). SPACELAB payload is 6371 kg (page 121, Ref 11) including a 21% mission managers reserve (914 kg). The 7300 kg value derives from replacing the 21% reserve with a 33% reserve, i.e., (6371-914) (1.33) = 7300 kg. This weight is for experiment equipment and mission peculiar equipment and does not include module weight, the volume however is for the complete module.

Average power requirement of 2000 watts is taken from SPACELAB payload data (Ref 11, p 68). Peak power of 3000 watts (AC) is taken from Ref 11, p 63.

Crew time requirements are derived from Ref 9 (Part II, p 15) aggregating individual operations typical of these types of medical experiments, and using a frequency of measurement based on the NASA Life Sciences hypotheses of Ref 4, p 6-8

PAYLOAD ELEMENT NAME
Animal and Plant Research Lab

CODE G D C D 0 3 0 1

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☒ Planned
- ☐ Candidate
- ☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 3600

OBJECTIVE 1) Provide a holding facility for continuous residency of plants and animals. 2) Provide a research laboratory for experiments in gravitational biology, radiogiology, musculoskeletal physiology, cardiovascularphysiology, endocrinology neurovestibular physiology, hematology and immunology, to elucidate basic mechanisms of adaptation to spaceflight.

TYPE
- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 4

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 10

DESCRIPTION Pressurized man-operated/man-tended (see special considerations) module containing animal holding facilities for rodents, acquatic species, and primates (5-6 single rack spaces), plant holding facilities (2-3 single rack spaces), laminal flow. Surgical workbench/biological containment facility, 0-1g centriguge and data analysis, and ECS isolated from rest of station. Primate holding facilities will initially accommodate 1-4 primates (e.g., squirrel monkeys to small Rhesus monkey) and at least one double rack will have flexibility to be upgraded to accommodate larger primates. Light, temperature and humidity control is provided. Access to sunlight may be needed.

CODE G D C D 0 3 0 1

ORBIT CHARACTERISTICS

Apogee, km Any Perigee, km Any Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	2000	21
Standby	1000	24
Peak	4000	3

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description
128 KBPS 6 Hr/Day, 8 KPBS 24 Hrs/Day

Data Types: ☐ Analog ☐ Digital ☒ Hrs/Day 6
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) 3 Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 128 Downlink Frequency (MHZ) ____

CODE G D C D 0 3 0 1

THERMAL

[X] Active [ ] Passive

Temperature, deg C operational min 20 max 26
non-operational min - max

Heat Rejection, w operational min 2000 max 5000
non-operational min max

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: [ ] Internal [ ] External [ ] Remote

Equipment ID/Function [ ] Pressurized [ ] Unpressurized

L,m 7.0 W,m 3.3 H,m 3.3 Stowed
L,m 7.0 W,m 3.3 H,m 3.3 Deployed

Launch mass, kg 4320

Consumables Types H_2O, O_2, Food (Plant/Animal)

Acceleration sensitivity, g min 5×10^{-5} (or 5E-05) max 10^{-3}

CREW REQUIREMENTS

Crew Size 2

Task Assignment

Skills (See Table B)

SKILL	2	2				
LEVEL	3	2				
Hrs/Day	3	3				

EVA [ ] YES [X] NO Reason Hrs/EVA

SERVICING/MAINTENANCE

SERVICE: Interval, days 90 Consumables, kg
Returnables, kg Man Hours

CONFIGURATION CHANGES: Interval, day 1080 Man/Hrs Req. 48
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions Of the experiments over 10 years performed approximately 20 of these will include the animal and plant research payload as a primary emphasis and 20 will include the presence of this payload element in its holding facility role only, with crew activities limited to housekeeping/caretaker roles. Data in this regard is for primary emphasis - other missions crew time (for task-trainable crew member) is 1 Hr/Day. Size includes module accommodation. Minimum g level is for some classes of plant experiments, e.g., polarization of cytoplasmic constituents. Other plant experiments need g levels of $<10^{-3}$-$<10^{-4}$. Crew time for service included in routine operations.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0301 ELEMENT NAME ANIMAL AND PLANT RESEARCH LAB

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1990 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 90 DAYS TOTAL SERVICES 40

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☐ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   6 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL 1080 DAYS TOTAL RECONFIGS. 3

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 16

   ☐ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Station OPS
2. Assume time included under station operations
3. 2 Crewen - 6 hours/day total; tend animal and plant, monitor instrumentation, handle specimens, biochemical and data analysis.
4. Update equipment for larger specimens.
5. Payload continues operation after 2000

TOTAL EVA HRS 0

Code: GDCD 0301

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Animal & Plant Research Lab

Reference Documents:

1. Life Sciences Considerations for Space Station, Life Sciences Division (EB-3), Office of Space Science and Applications NASA, Washington, DC 20546. September 14, 1982.

2. Report of the Study Panel for Plant Biology in Space Exploration, R.W. Krauss, Chairman, American Institute of Biological Sciences, June 24-25, 1978

3. Letter from R.W. Krauss, Executive Director, Federation of American Societies for Experimental Biology, to Dr. G.A. Soffen, NASA. Subject: Report of Committee Considering the Problems in Understanding the Effects of the Space Environment on Higher Plant Growth, July 6, 1982

4. Man Tended Life Sciences Research Facility: A Conceptual Design and Analysis Study; NASA Marshall Space Flight Center, January 1982

5. Spacelab Mission 4, Mission Definition Study Report Summary; Study Manager, M.J. Harnage, Jr., Johnson Space Center, November 1982

6. Final Reports of U.S. Experiments Flown on the Soviet Satellite Cosmos 782, edited by S.M. Rosenzweig and K.A. Souza, Ames Research Center, September 1978

7. Final Reports of U.S. Experiments Flown on the Soviet Satellite Cosmos 936, edited by S.M. Rosenzweig and K.A. Souza, Ames Research Center, September 1978

8. Life Sciences Research and the Science and Applications Space Platform, E.W. Gomersall, Coordinator, Biosystems Division, Ames Research Center, February 1982

9. Life Sciences Experiments for a Space Platform/Station; J.D. Fabricant, University of Texas, Medical Branch, Galveston Texas; Society of Automotive Engineers Technical Paper 820834, Twelfth Intersociety Conference on Environmental Systems, Sam Diego, July 1982

10. Life Sciences Mission Requirements Document (Draft) edited at Ames Research Center, November 1982

11. Life Sciences Laboratory Equipment (LSLE) Handbook, Johnson Space Center, 1981

12. Space Station User Fact Sheets and Contact Reports (attachments to letter to W. Hardy from R. Farrell, December 1982)

13. Life Sciences and Life Support Development Experiments on a Space Station, A.I. Skoog, Dornier System, GmbH, Document No. TN-SSS-DS-005, February 1983

Narrative:

This payload will enable the investigation of plants and animals living in a microgravity environment over their entire life cycle. The animal studies will include experiments for validating animal models of human physiology and experiments to elucidate basic mechanism of adaptation to microgravity (Ref 1, p 13, Ref 8 and 9). Plant research will include 14 areas of study of basic mechanisms (Ref 2 and 3) as well as applied research in support of future operational CELSS.

Facilities will be needed to hold live specimens including rodents, primates, aquatic species, higher plants and simple plants, microbial species, and tissue cultures. Facilities will also be needed for manipulation of the speciman and containment of all fluids and particulars associated with these manipulations (e.g., mass measurement, surgical procedures, drawing blood, biochemical analyses of plant/animal tissues, and specimen preservation and storage). A laminar air flow/glove-box type design is envisioned, such as the Spacelab-4 General Purpose Work Station. A centrifuge will be needed to provide various g levels from C.1g to 1.25g for a subset of the plant and animal population.

The specimen demands for the full range of research described in Ref 2, 3, 8, 9, and 10 would, if performed on the same mission, exceed the capabilties of the module recommended by Convair. However, a research program could be time-phased so that six single-rack-sized animal holding facilities and three single rack-sized plant holding facilities could accommodate a continuing Spacelab-4 design, and a representative experiment program would include 72 mice and 60 rats, and using a new design, three small rhesus monkeys. In the later years, new hardware would be needed to support the inclusion of larger primates in the payload.

Data in Ref 4 is taken for estimating payload weight, size and power required. From page 112 of Ref 4 (Spacelab long module #3A) payload weight is derived at 9520 lb (4320 kg), obtained from sum weight of ECLS (1762 lb), Equipment (1744 lb), assorted other items (1908 lb), expendables (3328 lb) and 25% contingency of (1762 + 1744). Module and associated equipment weight are not included in payload weight).

An operating power of 2kW is taken for this payload based on data in Ref 5. standby and peak powers of 1 and 4 kW, respectively, are judgemental values. Data transmission rates are taken from Ref 5. Ref 5 is used for power and data rates (vs Ref 4). The volume of 7 by 3.4 by 3.4 = 81.0m^3 approximates the volume of module 3A in Ref 4 (p 156), namely; 2808 cu. ft/35.3 = 79.5 m^3.

PAYLOAD ELEMENT NAME
EVA Performance and Productivity

CODE GDCD0322

CONTACT
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P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☒ Planned
- ☐ Candidate
- ☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 3600

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 4

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

OBJECTIVE

Monitor EVA physiological workload in relation to performance of broad spectrum of generic EVA tasks, and use to plan task loading, new tools, procedures, training and suit modifications.

DESCRIPTION During EVA, while performing many "typical" tasks, metabolic rate will be monitored based on measurement of heart rate, O_2 consumption/CO_2 production, core temperature and thermal load or body heat rejection required. Simultaneously, suited body motions will be monitored via film or video tape and subject to time and motion analysis. These physiological and phychophysical data will be combined with physical measurements (e.g., force, torque) and subjective judgements of the crew performing the tasks, and used to evaluate new tools, procedures, suit modifications in order to plan crew workload. Equipment is double rack mounted, including video monitor, biomedical data display, microcomputer, movie camera, stowage for tools, mobility devices and force measurements instruments. Reference GDCD 2402 for description of equipment.

CODE G D C D 0 3 2 2

ORBIT CHARACTERISTICS

Apogee, km Any Perigee, km Any Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	100	0.3 (2 Hrs/Wk)
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☒ Other TV
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☒ Hrs/Day 0.3 (2 Hrs/Wk)
Film (Amount) ____ Voice (Hrs/Day) 0.3 (2 Hrs/Wk)
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 0 3 2 2

THERMAL

☒ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☒ Internal ☐ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 1.5 W,m 0.75 H,m 2.75 Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 270

Consumables Types O_2/N_2

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2 Task Assignment ______

Skills (See Table B)

SKILL	2	7				
LEVEL	2	2				
Hrs/Day	0.25	0.25				

EVA ☒ YES ☐ NO Reason Routine Opeations Hrs/EVA 750

SERVICING/MAINTENANCE

SERVICE: Interval, days 90 Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day 720 Man/Hrs Req. 4

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Crew time for service included in routine operations. One crew member is EVA.

GDCD CODE 0322 ELEMENT NAME EVA PERFORMANCE AND PRODUCTIVITY

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1990 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 90 DAYS TOTAL SERVICES 40

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☐ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

.25 HRS PER DAY (INTERNAL)

.25 HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 720 DAYS TOTAL RECONFIGS. 5

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 4

☐ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

2. Video tapes, etc. crew time included under Station OPS
3. 1 crewman is for EVA routine operations associated with experiment
4. Change equipment
5. Payload continues operation after 2000

TOTAL EVA HRS 750

Code: GDCD 0322

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: EVA Performance & Productivity

Reference Documents:

1. SPACELAB Payload Accommodation Handbook SLP/2104. Issue No. 1, Revision No. 5. January 31, 1981

Narrative:

Many EVA tasks will be required for the Space Station. A new (hard) suit is planned as well as new tools. To assure that such tasks are done safely and efficiently, with best usa made of the new equipment, goals will need to be developed for human performance and productivity. Training methods need to be devised. This Payload encompasses these aspects. Double racks are planned to house equipment and tools. Data in Ref 1 is taken for rack size, weight, and data transmission rates.

PAYLOAD ELEMENT NAME
$H_2O/O_2/CO_2/N_2$ Regenerative Syst

CODE G D C D 0 3 4 0

CONTACT
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Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☒ Planned
- ☐ Candidate
- ☐ Opportunity

First flight, yr 1991
No. of flights 1
Duration of Flight, days 3650

OBJECTIVE

Development, verification, and integration of a regenerative life support system for operation in weightlessness -- in later years to provide revitalized atmosphere and clean water for extended periods with minimum resupply.

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 4

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

DESCRIPTION

Stand-alone and rack-mounted ECLS components/subsystems to verify zero-g operation of physical and chemical processes for H_2O reclamation, O_2 generation, CO_2 removal/reduction, and N_2 generation. Instruments for monitoring and control of regenerated atmosphere and water. Goal is to integrate verified components with space station operational systems.

ORIGINAL PAGE IS
OF POOR QUALITY

CODE GDCD0340

ORBIT CHARACTERISTICS

Apogee, km Any Perigee, km Any Tolerance + ______ - ______
Inclination, deg Any Tolerance + ______ - ______
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec ______ Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	2400	8
Standby		
Peak	4200	16

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☒ On-Board Data Processing Required
Description
Monitoring of Process Variables, 8 KBPS for 1 Hr/Day

Data Types: ☐ Analog ☒ Digital ☒ Hrs/Day 1
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 8 Downlink Frequency (MHZ) ______

CODE G D C D 0 3 4 0

THERMAL
☒ Active ☐ Passive
Temperature, deg C operational min ______ max ______
non-operational min ______ max ______
Heat Rejection, w operational min 50 max 100
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS
Location: ☒ Internal ☐ External ☐ Remote
Equipment ID/Function ☒ Pressurized ☐ Unpressurized
L,m 1.8 W,m 1.8 H,m 1.8 Stowed
L,m 1.8 W,m 1.8 H,m 1.8 Deployed
Launch mass, kg 1280
Consumables Types H_2O/O_2/Spares
Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS
Crew Size 2 Task Assignment ______
Skills (See Table B)

SKILL	7	7				
LEVEL	2	3				
Hrs/Day	0.5	0.5				

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE
SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______
CONFIGURATION CHANGES: Interval, day 720 Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions
Pointing/Orientation: May require heating/cooling relative to Sun/no Sun operation.
Installation Flexibility: Experimental subsystems should be removable/replaceable and have alternate interface possibilities relative to available space for connecting power and fluid lines into station operating systems.
Later years: Launch weight about 5000 Kg for 8 crew/90 days for developed system. Two types of reconfiguration of 6 and 48 hours, respectively.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0340 ELEMENT NAME $H_2O/CO_2/O_2/N_2$ REGENERATIVE SYSTEMS

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1991 INT. HRS 24 EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ______ DAYS TOTAL SERVICES ______

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

1.0 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 720 DAYS TOTAL RECONFIGS. 4

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 6 & 48

☐ NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Experiment peculiar setup time
3. Equipment operation
4. Reconfiguration: Initially 1993 at 6 hours; two years later massive reconfiguration 48 hours
   Repeat cycle three times. total = 108 m hours
5. Payload continues operation after 2000

TOTAL EVA HRS 0

Code: GDCD 0340

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: $H_2O/CO_2/O_2/N_2$ Regenerative System

Reference Documents:

1. Extended Mission Life Support Systems by P.O. Quattrone, NASA AMES Research Center, June 1981.

2. Space Station Technology Readiness by R.F. Carlisle and J.H. Romero. ASME National Meeting, Phoenix, Arizona. November 1982.

3. Space Station Technology by P.T. Holloway. NASA LRC presented at the 33rd International Astronautical Federation Congress, Paris, France, 1982

4. Space Station Environmental Control and Life Support System, Preliminary Conceptual Design by C.H. Lin. NASA JSC. Doc. No CSD-SS-059, JSC-17727, September 1982.

5. A Regenerative Life Support System for Space Operations Center (SOC). A probable First Flight application by H.F. Bros (Ham. Std.) ASME Paper 81-ENAs-12, 1981

6. Life Sciences Considerations for Space Station, Life Sciences Division (EB-3) Office of Space Science and Applications; NASA, Washington, D.C. 20546, Sept. 14, 1982.

7. Space Station Needs, Attributes and Architectural Options Contractor Orientation Meetings. Preliminary Agenda. Life Sciences Section by Dr. W. Bishop. Sept. 1982.

Narrative:

Life support of a space crew on an extended stay mission requires consideration of supply logistics for items such as cabin air, water, and removal of atmosphere contaminants like CO_2. The tack chosen here for this payload is research/development/integration experiments to obtain an operational closed type regenerative life support system by 1996. Time phasing is based initially on a system sized for a crew of two with sequential 90-day tests and modifications for a period of six years starting in 1991. After 1994, the system will be sealed-up to support a crew of eight operationally by 1996. Support for 8 people is assumed in Ref 1-5, including prior work.

By 1992, the system will recover potable water from humidity, waste water, and remove CO_2 from the atmosphere; this is t partially closed system to which reference will be made later with Figure 1. By 1994, further development will obtain additional closure, producing O_2 by electrolysis of reclaimed water, N_2 from hydrazine dissociation and reducing CO_2 to produce additional water; this is the additionally closed system. The foregoing 1990-1996 components of the regenerative systems are found in Ref 1 to 7; the 1991-1996 time phasing is Convair's judgement.

A 10-year completion time phasing for the regenerative system is projected in Ref 1, p 16, including in-flight demonstrations and system/subsystem/component developments. Using this 10-year period, the Convair 1996 projected operational date would require about 1986 as a work start date. An operational system is taken to include redundancies, fail safe/operational etc., which need not be full included in years prior to 1994, while experiments are in progress. Two regenerative units, each supporting four persons can also be considered.

Table 1 summarizes weight, volume and power for the 1991 launch, 1992 and 1994 updates, derived from the literature. Figure 1 taken from Ref 1 shows launch weights versus person days in space for an open loop and varying amounts of loop closure; the use of Figure 1 to obtain Table 1 will also be described.

The life support system is considered as "open loop" if much consumable resupply is needed. H_2O especially is a costly resupply payload item. Life support consumables can be regenerated on-board. Figure 1 predicts considerable launch weight reduction only by regenerating H_2O and removing CO_2; additional launch weight reduction is predicted with O_2 generation by electrolysis of water and CO_2 reduction to produce more water.

As example, Figure 1 shows with CO_2 removal, about 7700 pounds launch weight for 8 x 90 = 720 person days; the weight doubles if allowance is made for a 90-day contingency according to Ref 2, p 11. With decreasing mission duration, Figure 1 predicts more launch weight with increasing loop closure.

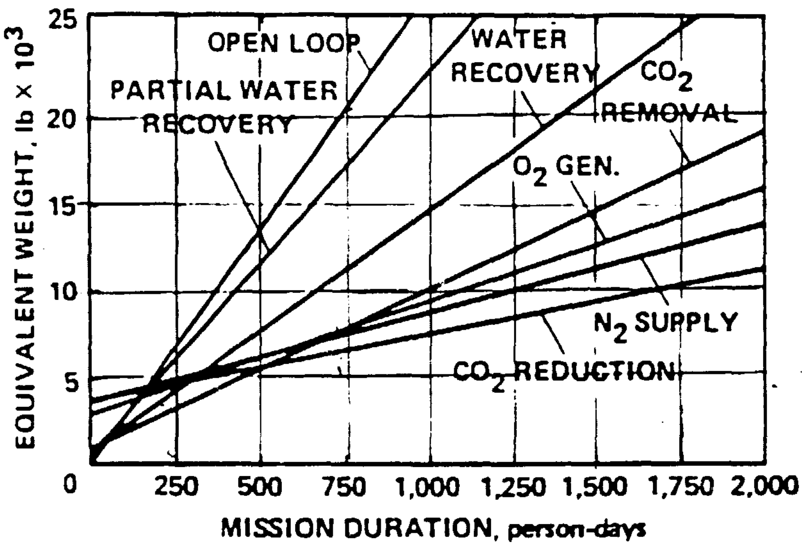
Ref 2 (p 11) and Ref 3 (p 11) suggest that the partially closed-loop system be included in the initial Space Station module. Whether the system will be operational by 1991 is not certain and seems to depend on the proof testing that can be done by the late 1980s. Ref 6, p 28 indicates the initial Space Station will use more consumables than required by the regenerative system and suggests that technology module packages be added-on to achieve an evolutionary regenerative capability; existing life support systems (open loop) would remain functional as a back-up, causing the early years consumable increase.

Table 1. Regenerative Life Support Time Phasing

EXPERIMENT	YEAR	CREW NO.	MISSION DAYS	WEIGHT°		VOLUME		POWER, KW		
				KG	LB	M^3	$(FT.^3)$	SUNLIT (58 MIN)	ECLIPSED* (38 MIN)	AVERAGE**
I	1990-92 INCLUDES CO_2 REMOVAL IN FIG 1	2	90	1280	2820	6	218	4.2	2.4	3.5
II	1992-94 INCLUDES CO_2 REDUCTION IN FIG 1	2	90	2064	4550	12	423	4.2	2.4	3.5
III	1994-96 SCALE-UP OF II***	8	90	5515	12,379	27	959	16.8	9.5	13.9

266.592-456-1

* ON BATTERY POWER
** KW, AVERAGE = [(SUNLIT KW) (58) + (ECLIPSE) (38)] /96
*** OPERATIONAL AFTER 1996
o DOES NOT INCLUDE POWER-WEIGHT PENALTY, TBD



SEQUENTIAL STEPS IN LOOP CLOSURE

DEFINITION	DESCRIPTION
PARTIAL WATER RECOVERY	HUMIDITY CONDENSATE COLLECTION
WATER RECOVERY	POTABLE WATER RECOVERY AND TREATMENT FROM URINE AND WASH WATER
CO_2 REMOVAL (NONEXPENDABLE)	REPLACEMENT OF EXPENDABLE LiOH WITH REGENERATIVE CO_2 COLLECTION TECHNIQUE
O_2 GENERATION	GENERATION OF O_2 THROUGH WATER ELECTROLYSIS USING RECLAIMED WATER
N_2 GENERATION	GENERATION OF N_2 THROUGH DISSOCIATION OF HYDRAZINE*
CO_2 REDUCTION	DECREASE IN EXPENDABLE WATER BY RECOVERING PRODUCT FROM CO_2 REDUCTION (SABATIER) PROCESS

<u>Approximating Equations for Figure</u> **

Open loop	weight = 27.2 (PD), lb
Water recovery	weight = 13.5 (PD) + 1250, lb
CO_2 removal	weight = 9 (PD) + 1200, lb
O_2 generation	weight = 6.5 (PD) + 3050, lb
CO_2 reduction	weight = 3.75(PD) + 3875, lb

* assuming hydrazine is available, say, for thruster control

** PD = person days

266.592.451

Figure 1. Regenerative vs Open Loop EC/LSS

The status of regenerative technology is discussed in Ref 5, p 8, noting that such technology is defined currently either from space tests or laboratory work. However, Ref 5, p 8, refers to the need for continued research and development to accomplishing the following: optimize equipment, require less crew monitoring, improve maintainability, increase system life, decrease weight and reduce power consumption.

These remarks imply a need for further development; a prototype regenerative system might be available for a 1990 launch if pertinent component tests are made before 1990 of a complete unit. In view of this current implied status, Table 1 denotes a 1991 launch of a partial regenerative unit for a crew of 2 and requiring in-orbit experiments for futher development. The 1992 launch also for a crew of 2 is shown in Table 1 as an update to include additional regenerative closure. Finally, the 1994 launch will be an updated 1992 system, but sized for a crew of 8 - and developed until operational in 1996.

Weight, volume, and power in Table 1 are estimated from data in Ref 1 and 5 as follows:

EXPERIMENT 1 (Table 1)

1. A 1991 launch weight of 2820 lb (1280 kg) is obtained from the Figure 1 water recovery line and is based on a crew of 3 for a 90-day mission (180-person days). This weight includes recovery of potable water from humidity, waste water and CO_2 removal from the atmosphere. There is no contingency supply in Figure 1.

2. System volume for the above weight can be estimated from data in Ref 6, p 7 showing 12, 379 lb, weight and a 959 ft^3 volume. These values yield 12, 379/959 = 12.9 lb/ft^3. Applying this density to the previous 2,820-lb weight leads to 2820/12.9 =219 ft^3 (6 m^3). Intuitively, the expection is for a volume to decrease slower than the weight ratio. However, the 12, 379 pounds in Ref 5 includes more features than the 2820-lb. system, such as CO_2 reduction of N_2, O_2, etc. Consequently, the 6 m^3 value will be taken.

3. System power for the 2820 lb system (item 1) is estimated at 4.2 kW during the sunlit part of the orbit and 2.4 when eclipsed (batteries required). These power values are based on Ref 6 data (12,379 lb system) of 16.8kW (sunlit, 58 minutes) and 9.5 kW (eclipsed, 38 minutes), reduced by the crew ratio 2/8; intuitively, the powering for air/water flow rates would seem dependent on crew number. Average power for a 96-minute orbit is estimated from (4.2 kW x 58 min. + 2.4 kW x 38 min.)/96 min. = 3.5 kW. Similarly, an average 13.9 kW value can be calculated for the 12, 379-lb system in Ref 6; for comparison Ref 4, p 4 lists a 21-day, 10-kW emergency electrical power for crew survival.

Similarly, for the 1992-1994 period, the following weight, volume, power is noted.

EXPERIMENT II (Table 1)

1. System weight in 1992 is estimated at 4550 lb (2064 kg) due to additional modules for further loop closure with O_2, N_2 generation, and CO_2 reduction. This weight is based on 180 person days in Figure 1. The weight increase 4550-2820 pounds above the Experiment I weight is inherent to the trade-off data in Figure 1 with decreasing person days.

2. Corresponding system volume is estimated at 423 ft^3 (12 m^3) and obtained from (4550/12.9) x (1.2) = 423 ft^3. This result is for a reduced scale of the system in Ref 5 p 7; the 1.2 factor is a judgement that volume may not decrease directly with weight for the scaled down version.

3. System power is estimated 16.8 x 2/8 = 4.2 kW (sunlit) and 9.5 x 2/8 = 2.4 kW (eclipsed) - assuming, as before, that power is proportional to the crew number, data in Ref 5, pp 7 and 8. Average power, similarly is 3.5 kW.

   The operational system in 1996 for 8 persons is a scale-up from the 2 person experimental system of 1992-1994; weight volume, power of the 8 person system follow next.

EXPERIMENT III (Table 1)

1. Weight is 12, 379 lb (5515 kg) for a crew of 8 on a 90-day mission, taken directly from Ref 5, p 7. This weight is about twice the value obtained from Figure 1 for the CO_2 reduction line at 720 person days. The weight difference is due mostly to the additional functions in Ref 5 that are not believed to be included in Figure 1; namely, cabin ventilation and thermal control, heat transport and rejection; health and hygiene, EVA/IVA support and spares.

2. Correspooding volume is 959 ft^3 (27 m^3), taken directly from Ref 5.

3. Corresponding power taken from Ref 5 is 16.8 kW (58 min. sunlit), 9.5 kW (38 min. eclipse) and 13.9 kW average.

PAYLOAD ELEMENT NAME
CELSS Experimental Systems

CODE G D C D 0 3 4 1

TYPE
- [x] Science & Applications (non-commercial)
- [ ] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A) 4

CONTACT
Name / Address: W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- [ ] Operational
- [ ] Approved
- [x] Planned
- [ ] Candidate
- [ ] Opportunity

First flight, yr 1992
No. of flights 1
Duration of Flight, days 2190

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

OBJECTIVE

Develop, verify and integrate components of a space station life support system which minimizes resupply of food, water and oxygen and processes organic wastes for maximum reuse.

DESCRIPTION Stand-alone equipment for waste recycling, water recovery, atmospheric revitalization (e.g., wet oxidation waste processor) plant growth chambers with species of edible higher plants (e.g., lettuce, tomatoes, carrots, wheat, soybeans, peanuts), algae cultures (e.g., spirulina), yeasts. There will be prototype control instrumentation such as flow meters and nutrient concentration monitors. Verification is required of component operation in zero-g. Trial of candidate integration scenarios including artificial vs sunlight plant irradiance, different "day/night" cycles, different plant species and percentage of crew diet supplied by plants, and trade-offs to optimize the system. Reference GDCD 1303 for commercial use.

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ORBIT CHARACTERISTICS

Apogee, km Any Perigee, km Any Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐Inertial ☐Solar ☐Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐AC ☐DC

	Power, W	Duration, hrs/day
Operating	4400	23
Standby		
Peak	6000	1

☐Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐None ☐Realtime ☐Offline ☐Other ____
☐Encryption/Decryption Required
☐Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐On-Board Data Processing Required
Description ____

Data Types: ☐Analog ☐Digital ☐Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

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THERMAL
☒ Active ☐ Passive

Temperature, deg C operational min 20 max 26
non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☒ Internal ☐ External ☐ Remote

Equipment ID/Function ☒ Pressurized ☐ Unpressurized

L,m 3 W,m 3 H,m 3 Stowed
L,m 3 W,m 3 H,m 3 Deployed

Launch mass, kg 2625
Consumables Types H_2O/O_2/Plant Nutrients
Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 2 Task Assignment ____

Skills (See Table B)

SKILL	7	7	5			
LEVEL	3	2	3			
Hrs/Day	0.5	0.5	1			

EVA ☐ YES ☒ NO Reason ____ Hrs/EVA ____

SERVICING/MAINTENANCE

SERVICE: Interval, days 90 Consumables, kg 137
Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day 720 Man/Hrs Req. ____
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions Crew time for service included in routine operations. Pointing/Orientation: May need access to sunlight for photosynthesis experiment (plant/algae/yeast). Two types of reconfiguration of 8 and 48 hours, respectively. May need to consider interface with advanced regenerative life support components (GDCD 0340). Updates in 1994 and 1996 with mass, volume and power increasing to 5250/56/8.8 and 10,500/111/17.5, respectively. Consumables are 275 kg (1994-1996) and 550 kg (1996-1998). Cross training for different skills.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0341 ELEMENT NAME CELSS EXPERIMENTAL SYSTEMS

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1992 INT. HRS 24 EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 90 DAYS TOTAL SERVICES 24

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☐ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   2.0 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL 720 DAYS TOTAL RECONFIGS. 2

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 8 & 48

   ☐ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) 1998 INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Experiment peculiar setup time
2. Plant nutrients, consumables. Crew time assumed as part of routine ops.
3. Equipment tests
4. Initial reconfiguration needs 8 man hours; 2nd reconfiguration is a major reconfiguration and requires 48 man hours.
5. Station OPS

TOTAL EVA HRS 0

Code: GDCD 0341

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: CELSS Experimental Systems

Reference Documents:

1. NASA Information Bulletin on CELSS. Ames Research Center. 10/82

2. Foundations of Space Biology and Medicine. Volume III, Space Medicine and Biotechnology, Chapter 10. Biological Life Support Systems, Washington, D.C. 1975.

3. Life Science and the Science and Applications Space Platform by E.W. Gomersall, Ames Research Center January 1982.

4. Controlled Ecological Life Support Systems (CELSS) Program Plan. NASA EBT-3/Chief, Biological Systems Research. March 1982.

5. Life Sciences considerations ›r Space Station, Life Sciences Division (EB-3). Office of Space Science and Application; NASA, Washington, D.C. 20541. September 14, 1982.

6. Controlled Ecological Life Support System: Transportation Analysis by E. Gustan, T. Vinopal. NASA Contractor Report 166420 by Boeing Aerospace Co. for ARC. November 1982.

7. Controlled Ecological Life Support System. First Principal Investigators Meeting. Edited by B. Moore, III, R. A. Wharton, Jr. and R. D. MacElroy. NASA Conference Publication 2247. Published 1982.

8. CELSS Principal Investigators Conference. Abstracts. December 6-8.

Narrative:

A Controlled Ecolog ca' Life Support System (CELSS) has the potential to provide food and envi›onmental control with energy input and a minimum of resupply. CELSS is a closed-loop type system, requiring equipment to recycle water, air, waste (human, plant), monitor water/air, grow food, and store supplies produced; see Ref 1. Estimates are given for CELSS weight, volume and power, starting from a 1992 launch with upgrades until operational in 1996.

Fundamental CELSS background aspects are described, for example, in Ref 2 on plant growth, waste utilization, experimental systems and mathematical modeling. From Ref 2, the basic CELSS operations are seen to be: water reclamation, air revitalization, waste management, food growing; these items are combined in Ref 3 to denote three major CELSS research areas; namely, waste management, food production, and system control.

Time phasing for the above CELSS development, design, and test is given in Ref 4, p. 43, showing: by 1985 definition of food to be grown, and subsystem waste management; by 1987 selection of optimal system approach, by 1990 start of experiments. With experiments starting in 1990, Ref 3 suggests that CELSS may be able to supplement Space Station food supply by the mid 1990's (page 12, Program Plan); this ability includes H_2O and O_2 generation, implicit to the CELSS concept.

A CELSS equipment build-up for experiments, in modular form is anticipated after 1992; some CELSS equipment is similar to that for regenerative life support experiments in GDCD 0340. This similarity is noted in Ref 5, p 29, offering the possibility for equipment sharing during the development of both systems and when both are operational.

Ref 6 considers a complete CELSS food growing installation (4 men) and trade-offs with an equivalent 100% resupply system. Conventional type vegetables are assumed for the Ref 6 CELSS study. Other food types are being considered in NASA's programs, such as yeast and algae; see Ref 7 and 8.

An estimate of the CELSS characteristics will be made using data in Ref 6; there, the 1990 CELSS launcn weight is given for 0, 50, and 97% food closures based on growing conventional food-vegetables for a crew of 4 - in all three cases, water/air closure is 100%. The 1990 CELSS launch availability requires continuous development starting from the mid-1980s, as noted.

Convair's projected time phasing for CELSS is listed in Table 1; assumptions made are: CELSS will be operational in 1998 (versus 1990 in Ref 6), feeds 4 persons with 50% food closure and 100% water/air closure. Reasons for selecting this 50% value are:

1. Less launch weight after 1996 vs 0% food closure, compared with a 1998 breakeven data for 97% food closure; see Ref 6, p 83 (a 0% food closure requires 100% food resupply).

2. A $20,000,000 lower cumulative cost estimate (at this stage of development) between the 1996 (50%) and 1998 (97%) dates for item 1 - see Ref 6. p 100.

3. A 50% vegetarian diet may be acceptable to a non-vegetarian crew person (or one not preconditioned to eat mostly vegetables.

Code: GDCD 0341 PAYLOAD ELEMENT SYNTHESIS

Table 1. CELSS Time Phasing Experiments*
(50% Food Closure/Person, 100% water/air closure/person)

ITEM	YEAR	TASK	CELSS CREW SIZING	WEIGHT° kg	WEIGHT° lb	VOLUME(a) M^3	VOLUME(a) FT^3	POWER kW	CONSUMABLES, kg oo
1	1992-1994	EXPERIMENTAL	1	2625 (7560)	5790 (16,700)	28	980	4.4	138
2	1994-1996	EXPERIMENTAL	2	5250 (10,190)	11,600 (22,500)	56	1960	8.8	275
3	1996-1998	EXPERIMENTAL	4	10,500 (15,500)	(23,200) (34,400)	111	3920	17.5	550
4	1998	OPERATIONAL	4	10,500 (15,500)	23,200 34,100	111	3920	17.5	550

* Based on data in Ref 6, p 76 showing 10,500 kg CELSS weight for a crew of 4

** 10,500/4

o Numbers in parenthesis include CELSS module weight of 4888 kg plus 47 kg (resupply module with volume 1.7 m^3); see Ref 6, pp 70 and 76.

oo Consumables = 550/crew where 550 is Ref 6 value for four persons (p 76)

(a) Does not include 1.7 m^3 volume of resupply module, Ref 6 p 76.

Table 1 assumes CELSS weight, volume and power vary directly with crew size being fed by CELSS; the nominal CELSS weight is 10,500 kg (4 people) given in Ref 6, p 76.

The study of Ref 6 locates CELSS equipment in a pressurized module of 4888 kg weight and 111 m^3 volume. Ref 6 also uses a resupply module, weight 47 kg, 1.7 m^3 volume (p 76). Mission data set sheets do not include the weights and volume of a CELSS and resupply module.

CELSS food growing components are listed in Ref 6, p 58; included in the listing are a plant growth area of 14 m^2/person and 150 watts/m^2 illumination power for 4 persons ,38 watts/person); these values are based on 50% food closure/4 persons.

Additional background data on NASA's funded CELSS program are found in Ref 7 and 8.

Though Table 1 is based on conventional vegetable type food, Ref 4, p 38 includes algae, bacteria, yeast, and chemical synthesis as food to be evaluated. These food types need consideration of toxicity to humans relative to environmental interaction, Ref 6, p 39.

Perhaps one other food type besides the conventional vegetables can be CELSS evaluated in space between 1990-1992; equipment commonality will be needed for the two food types and a decision made by 1992. If not, the food choice by 1988 seems needed if CELSS is to be space operational by 1998. The subject needs early attention relative to CELSSs.

Regarding early year CELSSs activities, Ref 5, p 29 foresees the following experiments:

- Evaluating equipment performance (similar to regenerative life support systems)
- Biological processes in weightlessness
- Biological systems interacting with the spacecraft environment - during first three years

A final point concerns continuing experimentation with algae, yeast, etc. well into the 1990s. The CELSS pallet concept GDCD 0343 supports this possibility in conjunction with GDCD 0301 - the Animal and Plant Research Laboratory.

PAYLOAD ELEMENT NAME
Dedicated CELSS Module

CODE G D C D 0 3 4 2

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

☐ Operational
☐ Approved
☒ Planned
☐ Candidate
☐ Opportunity

First flight, yr 1996
No. of flights 1
Duration of Flight, days 1460

TYPE

☒ Science & Applications (non-commercial)
☐ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 4

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

OBJECTIVE

Produce food, revitalize atmosphere, recover water and process/recycle organic solid and liquid waste -- late 1990's objective include growth of 50% of crew food, 100% of water from reclamation and useful amounts of oxygen.

DESCRIPTION

CELLS is a man-tended system for growing food (e.g., lettuce, tomato, wheat, soybeans, peanuts) waste recycling, water recovery and atmospheric recycling. Plants will supply 50% of diet for a crew of 4. Growing area is 60 Sq. M. Approximately 18 Kw of power is needed for plant growth with artificial lights and equipment operation. Also contains a food processing station, a harvesting station, monitoring and control instrumentation. Reference GDCD 1304 for commercial use. See GDCD 0341 which is a related mission.

CODE G D C D 0 3 4 2

ORBIT CHARACTERISTICS

Apogee, km Any Perigee, km Any Tolerance + ______ –

Inclination, deg Any Tolerance + ______ –

Nodal Angle, deg ______ Ephemeris Accuracy, m ______

Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ______

Pointing accuracy, arc sec ______ Field of view, deg ______

Pointing Stability (Jitter) arc sec/sec ______

Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	18,000	23
Standby		
Peak	22,000	1

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☐ Realtime ☐ Offline ☐ Other ______

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______

☐ On-Board Data Processing Required

Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______

Film (Amount) ______ Voice (Hrs/Day) ______

Live TV (Hrs/Day) ______ Other ______

On-Board Storage (MBIT) ______

Data Dump Frequency (Per Orbit) ______

Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

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CODE G D C D 0 3 4 2

THERMAL

[X] Active [ ] Passive

Temperature, deg C operational min ____ max ____
non-operational min ____ max ____

Heat Rejection, w operational min 3000 max 18,000
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: [ ] Internal [ ] External [ ] Remote

Equipment ID/Function [ ] Pressurized [ ] Unpressurized

L,m 5.5 W,m 4.5 H,m 4.5 Stowed
L,m 5.5 W,m 4.5 H,m 4.5 Deployed

Launch mass, kg 10,500

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 2 Task Assignment ____

Skills (See Table B)

SKILL	7	2				
LEVEL	2	2				
Hrs/Day	4	4				

EVA [ ] YES [X] NO Reason ____ Hrs/EVA ____

SERVICING/MAINTENANCE

SERVICE: Interval, days 90 Consumables, kg 550
Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day 720 Man/Hrs Req. 40
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Back-Up Power: Needs definition for critical components in event of power failure. Animal Food for Vivarium: May be obtainable from CELSS plant food (TBD). Crew time for service included in routine operations.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0342 ELEMENT NAME DEDICATED CELSS MODULE

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1996 INT. HRS 48 EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 90 DAYS TOTAL SERVICES 16

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☐ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   6 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL 720 DAYS TOTAL RECONFIGS. 2

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 40

   ☐ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Experiment peculiar setup
2. Bring new plants, seeds from earth, unpackage (incl. in station ops support)
3. Planting new crops, maintaining crops
4. Updating waste processing and other hardware
5. Payload operation continues after 2000

TOTAL EVA HRS 0

Code: GDCD 0342

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Dedicated CELSS Module

Reference Documents:

1. GDCD 0341, payload element synthesis for CELSS Experimental Systems

Narrative:

This payload development derives from Ref 1 for an operational CELSS in 1996, for a four person crew, providing 50% food (vegetables), 100% water/atmosphere. Ref 1 describes a CELSS experiment program starting from a 1992 launch with 1994, 1996 upgrades. From 1996 until 1998, the CELSS configuration should be close to the operational CELSS relative to size, weight, volume, and power. Numerical data are given in Ref 1.

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PAYLOAD ELEMENT NAME
CELSS Pallet

CODE
G D C D 0 3 4 3

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1996
No. of flights 1
Duration of Flight, days 2190

OBJECTIVE

Grow algae and yeast cultures for possible food use.

TYPE

- ☒ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 4

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

DESCRIPTION

Four 80 gallon tanks with windows for sunlight, will be mounted on a pallet attached to the CELSS located module. Three of the tanks will contain algae (e.g., spirulina) and one will contain yeast, for experiments related to food supplementation. Appropriate nutrient media is required with instrumentation to monitor and control chemical input/output and plumbing connecting the tanks to the CELSS module for harvesting. May need separate dump systems for algae and yeast.

CODE G D C D 0 3 4 3

ORBIT CHARACTERISTICS

Apogee, km Any Perigee, km Any Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☒ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	600	24
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☒ On-Board Data Processing Required
Description
Offline downlink is 1 KBS for 1 Min/Hr.

Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day ____
Film (Amount) x Voice (Hrs/Day) ____
Live TV (Hrs/Day) 0.2 Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 1 Downlink Frequency (MHZ) ____

CODE GDCD0343

THERMAL

☒ Active ☐ Passive

Temperature, deg C operational min 20 max 26
non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 1.0 W,m 2.5 H,m 0.5 Stowed

L,m 1.0 W,m 2.5 H,m 0.5 Deployed

Launch mass, kg 1300

Consumables Types H_2O, Growth Nutrients

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 2

Task Assignment Service Pallet

Skills (See Table B)

SKILL	7	2				
LEVEL	1	2				
Hrs/Day	0.25	0.25				

EVA ☒ YES ☐ NO Reason Instl/Monthly Insp Hrs/EVA 33

SERVICING/MAINTENANCE

SERVICE: Interval, days 90 Consumables, kg 150
Returnables, kg 150 Man Hours 4

CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Pointing Characteristics: Sunlight required for number of hours/day to be determined by early experiments. Configuration Changes: Algae/yeasts can be used for food. Initially plant matter might be returned to Earth for testing; later, algae/yeast will be used for food preparation. Nutrient servicing is required. TV Monitoring: 10 min/day is included for external systems status check.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0343 ELEMENT NAME CELSS PALLET

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1996 INT. HRS 8 EVA HRS 6 EVA CREW 2

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 90 DAYS TOTAL SERVICES 16

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE 4

   ☐ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.5 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA) See Note 3

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Initial setup of plants
3. EVA 0.5 hr to inspect 1/month = 27 hours total through 2000
5. Payload operation continues after 2000

TOTAL EVA HRS 33

Code: GDCD 0343

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: CELSS Pallet

Reference Documents:

1. Life Sciences Considerations for Space Station, Life Sciences Division (EB-3), Office of Space Science and Application; NASA. Washington, D.C. 20546.

2. Controlled Ecological Life Support System (CELSS) Program Plan. NASA EBT-3/Chief, Biological Systems Research. March 1982.

3. Air Pollutant Production By Algal Cell Cultures by F. Fongand, E.A. Funkhouser in Controlled Ecological Life Support System. First Principal Investigators Meeting. NASA Conference Publication 2247. Published 1982.

4. CELSS Principal Investigators' Conference. (NASA). Abstracts. December 1982.

Narrative:

The use of a pallet for holding algae and yeast type cultures in tanks is based on the following reasons:

- Saves module space since the required culture environment is a water environment.
- Ease of exposing tanks (transparent) to sunlight.
- Reduced risk for toxic interaction with module environment.

The need for the cultures is in relation to CELSS food growth experimentation. Cultures are to be drawn off from the tanks into a work module for experimentation.

Ref 1, p 30 suggests the use of sunlight for transparent containers. Possible toxicity of cultures is noted in the literature, Ref 2, p 39 and Ref 3, p 57. The foregoing considerations suggest the use of a pallet.

Culture nominal temperature in the tanks will probably be in the range similar to the normal values for human beings (20 to 26 C). However, Ref 4, p 17 notes a test at 30 C with one culture type.

Four tanks are chosen to hold the cultures, each at 80 gallons. Ref 1, p 30 mentions tanks of about 200 gallons, however, the 80-gallon size seems suited to the pallet concept. Culture weight, water based, in 320 gallons is about 2500 lb; weight of four tanks (dry) is estimated at about 300 lb (minimum). Total weight, tank plus culture becomes 2800 lb. (1300 kg).

Section 1.5

Discipline Materials Processing

GDCD ID NO.	PAYLOAD ELEMENT NAME
0400	Research and Development Facility
0401	R&D/Proof of Concept Facility

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PAYLOAD ELEMENT NAME Research and Development Facility	**CODE** G D C D 0 4 0 0	**TYPE** ☒ Science & Applications (non-commercial) ☐ Commercial ☐ Technology Development ☐ Operations Type Number (see Table A) 5
CONTACT **Name** W. Hardy/J. Peterson MZ 21-9530 **Address** General Dynamics Convair Division P.O. Box 85357 San Diego, CA 92138 **Telephone** (619) 277-8900, Ext. 3778/2130		
STATUS ☐ Operational ☐ Planned ☐ Approved ☒ Candidate ☐ Opportunity		
First flight, yr 1990 No. of flights 1 Duration of Flight, days 1460		**Importance of the Space Station to this Element** 1 = low value but could use 10 = vital Scale 1 - 10 10
OBJECTIVE Provide a small scale general purpose materials science research and development facility for early year operations.		
DESCRIPTION This facility contains processing and support equipment to conduct research and development experiments in the areas of solidification, crystal growth, bioprocessing and fluid, chemical and combustion experiments.		

CODE G D C D 0 4 0 0

ORBIT CHARACTERISTICS

Apogee, km >400 Perigee, km >400 Tolerance + -
Inclination, deg Any Tolerance + -
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec ______ Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☒ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	10,000	22
Standby	150	
Peak	13,000	2

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☒ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day 24.
Film (Amount) ______ Voice (Hrs/Day) 1.
Live TV (Hrs/Day) .25 Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) 3.
Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

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CODE G D C D 0 4 0 0

THERMAL

☒ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min 10,000 max 13,000
non-operational min 150 max 150

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☒ Internal ☐ External ☐ Remote

Equipment ID/Function ☒ Pressurized ☐ Unpressurized

L,m 4.5 W,m .75 H,m 2.0 Stowed
L,m 4.5 W,m .75 H,m 2.0 Deployed

Launch mass, kg 1736

Consumables Types Raw Materials, Fluids, LN_2

Acceleration sensitivity, g min 10^{-5} max ______

CREW REQUIREMENTS

Crew Size 1

Task Assignment ______

Skills (See Table B)

SKILL	5	2	5			
LEVEL	2	3	3			
Hrs/Day	2	1	1			

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Vacuum vents are required. Cross training of skills.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 0400 ELEMENT NAME RESEARCH AND DEVELOPMENT FACILITY

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1990 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   4 HRS PER DAY (INTERNAL) 26 days per month

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) 1994 INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. Station operations
3. Crew activity description: Monitor control/manipulate, measure/record, load/unload samples, clean out equipment, preserve and package samples. Repair equipment as required.
   Some equipment operates 24 hours per day

TOTAL EVA HRS 0

Code: GDCD 0400

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Research and Development Facility

Reference Documents:

1. TRW Report MPS .6-80-286, Vol. II, "MEC Payloads Handbook," 30 January 1981.

Narrative:

This is a general purpose R&D facility for Materials Science research and physics and chemistry experiments in fluid behavior, chemical reactions and combustion. Limited product analytical capabilities are included, therefore, most analyses must be conducted after the products are returned to ground laboratories.

The facility contains three sets of processing modules and three corresponding support modules as shown below.

Processing Module		Support Module	Pwr kW	
ASES/HGDS	(1)	1	1.5-10.	10/13
FZ	(1)			
VCG	(1)			
SCG	(1)			
BIO	(2)	1	0.5-3.0	
F/C	(1)	1	0.2-1.0	

Since the four furnaces share one support module, only one can be operated at a time.

Equipment physical characteristics were derived from Ref 1. They are summarized in Table 0400-1.

Launch date and mission duration were derived.

The following general comments apply to 0400, 0401, and 1200 thru 1205:

1. Description data for all attached payload elements is based upon MPS .6-80-286, Vol. II, MEC Payloads Handbook (TRW). All mass and volume values include a 25% growth factor.

2. Power levels shown are for the largest specimen sizes.

3. Abbreviations used are as follows:

AC	Acoustic Containers
ASES	Advanced Solidification Experiment System
BIO	Biological
CFE	Continuous Flow Electrophoresis
EMC	Electromagnetic Containerless
ESC	Electrostatic Containerless
FZ	Floating Zone
F/C	Fluids/Chemistry
HGDS	High Gradient Directional Solidification
IEF	Isolectric Focusing
SCG	Solution Crystal Growth
SEC	Stationary Electrophoresis Column
VCG	Vapor Crystal Growth

4. The source data expresses equipment size in terms of volume rather than dimensions. In a manned laboratory the equipment would be packaged in equipment racks, or with dimensions similar to racks. Therefore, to derive the L by E by H dimensions required for the Payload Element Data Sheets, rack cross-sections of 2m high by 0.75m deep were assumed. The rack length was then calculated by: $L = \frac{V}{1.5}$ m

Table 0400-1
EQUIPMENT PHYSICAL CHARACTERISTICS

PROCESS (QTY)		PROCESSING MODULE		SUPPORT MODULE		TOTALS	
		MASS kg	VOLUME m^3	MASS kg	VOLUME m^3	MASS kg	VOLUME m^3
ASES/HGDS	(1)	512	1.4				
FZ	(1)	186	0.5				
VCG	(1)	100	0.5	488	2.25	1336	5.15
SCG	(1)	50	0.5				
BIO	(2)	30	0.1	170	0.5	200	0.6
Fluids/ Chemistry	(1)	120	0.5	80	0.5	200	1.0
				TOTAL		1736 kg	6.75 m^3

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PAYLOAD ELEMENT NAME
R&D/Proof of Concept Facility

CODE G D C D 0 4 0 1

TYPE
- [x] Science & Applications (non-commercial)
- [ ] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A) 5

CONTACT
Name / Address: W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- [ ] Operational
- [ ] Approved
- [ ] Planned
- [x] Candidate
- [ ] Opportunity

First flight, yr 1994
No. of flights 1
Duration of Flight, days 2555

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

OBJECTIVE

Provide moderate scale general purpose materials science research and development facility for mid- and late-year operations.

DESCRIPTION

This facility contains processing and support equipment to conduct research and development proof of concept experiments in the areas of solidification, crystal growth, containerless processing, bioprocessing and fluid, chemical and combustion experiments.

CODE G D C D 0 4 0 1

ORBIT CHARACTERISTICS

Apogee, km >400 Perigee, km >400 Tolerance + -
Inclination, deg Any Tolerance + -
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec ______ Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☒ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	25,000	22
Standby	150	
Peak	35,000	2

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☒ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☒ Digital ☒ Hrs/Day 24
Film (Amount) ______ Voice (Hrs/Day) 2
Live TV (Hrs/Day) 1 Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 6 Downlink Frequency (MHZ) ______

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CODE
G D C D 0 4 0 1

THERMAL
☐ Active ☐ Passive
Temperature, deg C operational min ______ max ______
non-operational min ______ max ______
Heat Rejection, w operational min 150 max 35,000
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS
Location: ☐ Internal ☐ External ☐ Remote
Equipment ID/Function ☐ Pressurized ☐ Unpressurized
L,m 7.97 W,m .75 H,m 2. Stowed
L,m 7.97 W,m .75 H,m 2. Deployed
Launch mass, kg 3224
Consumables Types Raw Materials, Fluids, LN_2
Acceleration sensitivity, g min 10^{-5} max ______

CREW REQUIREMENTS
Crew Size 1
Task Assignment ______
Skills (See Table B)

SKILL	5	2	5			
LEVEL	2	3	3			
Hrs/Day	4	2	2			

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE
SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______
CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions
Vacuum vents are required. Cross training of skills.

GDCD CODE 0401 ELEMENT NAME R&D/PROOF OF CONCEPT FACILITY

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1994 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

8 HRS PER DAY (INTERNAL) 26 days per month

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. Station operations
3. Crew activity description: monitor, control/manipulate, measure/record, load/unload samples, clean out equipment, analyze samples, preserve and package samples. Repair equipment as required.
Some equipment operates 24 hours per day.

TOTAL EVA HRS 0

Code: GDCD 0401

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Research & Development/Proof of Concept Facility

Reference Document:

1. TWR Report MPS .6-80-286, Vol. II, "MEC Payloads Handbook", 30 January 1981.

Narrative:

This facility provides materials Science R&D capabilities in all MPS areas, and supports proof of concept experiments. It includes the same furnace and fluids/chemistry equipment as P/L-0400, but expands the BIO capabilities by a factor of three and adds containerless processing capabilties. Moderate product analysis capabilties are included.

The facility contains four sets of processing modules and four corresponding sets of support modules as shown below

PROCESSING MODULE		SUPPORTMODULE	Pwr, kW	
ASFS/HGDS	(1)			
FZ	(1)	1	1.5-20	
VCG	(1)			
SCG	(1)			
AC	(1)			
EMC	(1)	1	2.5-25	25/35
ESC	(1)			
BIO	(6)	1	1.0-10	
F/C	(1)	1	0.2-1.0	

The furnaces share support modules and only one can be operated at a time per support module.

Equipment physical characteristics were derived from Ref 1. They are summarized in Table 0401-1.

Launch date and mission duration were derived.

Code: GDCD 0401 PAYLOAD ELEMENT SYNTHESIS

1. Description data for all attached payload elements is based upon MPS .6-80-286, Vol. II, MEC Payloads Handbook (TRW). All mass and volume values include a 25% growth factor.

2. Power levels shown are for the largest specimen sizes.

3. Abbreviations used are as follows:

AC	Acoustic Containers
ASES	Advanced Solidification Experiment System
BIO	Biological
CFE	Continuous Flow Electrophoresis
EMC	Electromagnetic Containerless
ESC	Electrostatic Containerless
FZ	Floating Zone
F/C	Fluids/Chemistry
HGDS	High Gradient Directional Solidification
IEF	Isolectric Focusing
SCG	Solution Crystal Growth
SEC	Stationary Electrophoresis Column
VCG	Vapor Crystal Growth

4. The source data expresses equipment size in terms of volume rather than dimensions. In a manned laboratory the equipment would be packaged in equipment racks, or with dimensions similar to racks. Therefore, to derive the L by W by H dimensions required for the Payload Element Data Sheets, rack cross-sections of 2m high by 0.75m deep were assumed. The rack length was then calculated by: $L = \frac{V}{1.5}$ m

Table 0401-1
EQUIPMENT PHYSICAL CHARACTERISTICS

PROCESS (QTY)	PROCESSING MODULE MASS kg	PROCESSING MODULE VOLUME m^3	SUPPORT MODULE MASS kg	SUPPORT MODULE VOLUME m^3	TOTALS MASS kg	TOTALS VOLUME m^3
ASES/HGDS (1)	512	1.4				
FZ (1)	186	0.5				
VCG (1)	100	0.5	488	2.25	1336	5.15
SCG (1)	50	0.5				
AC (1)	288	1.0				
EMC (1)	350	1.1	412	1.5	1338	4.6
ESC (1)	288	1.0				
BIO (6)	90	0.3	260	0.9	350	1.2
Fluids/ Chemistry (1)	120	0.5	80	0.5	200	1.0
			TOTAL		3224 kg	11.95 m^3

COMMERCIAL MISSIONS

Section 2.1

Discipline Earth and Ocean Observations

GDCD ID NO.	PAYLOAD ELEMENT NAME
1000	Geological Reconnaissance
1001	Remote Atmospheric Sensing
1002	Worldwide Cotton Acerage and Production
1003	Petroleum and Mineral Location

PAYLOAD ELEMENT NAME
Geological Reconnaissance

CODE GDCD1000

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 1825

TYPE
☐ Science & Applications (non-commercial)
☒ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 6

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 2

OBJECTIVE

Use Earth scanning devices for location of possible hydrocarbon reservoirs or for seismic location, or possibly for weather monitoring.

DESCRIPTION

Use station to test experimental scanners, change out modules, build modular satellites and launch into polar orbit. Use LANDSAT-type experimental Earth scanning systems for exploration, probably in a sun synchronous polar orbit. May involve joint venture for iceberg and weather tracking for offshore platforms, seismic boats. The exploration phase using free flyer is described herein.

Ref. GDCD 0174 or GDCD 0175 could accommodate development/test of scanners.
Ref. GDCD 0172 could accommodate the exploration phase.

CODE G D C D 1 0 0 0

ORBIT CHARACTERISTICS

Apogee, km 500 Perigee, km 500 Tolerance + 100 - 200

Inclination, deg 90 Tolerance + 10 - 10

Nodal Angle, deg ____ Ephemeris Accuracy, m ____

Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth

Truth Sites (if known) Earth targets are required

Pointing accuracy, arc sec <1.0 Field of view, deg ____

Pointing Stability (Jitter) arc sec/sec ____

Special Restrictions (Avoidance) Desire Earth swaths

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☒ Realtime ☐ Offline ☐ Other ____

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____

☐ On-Board Data Processing Required

Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____

Film (Amount) ____ Voice (Hrs/Day) ____

Live TV (Hrs/Day) ____ Other ____

On-Board Storage (MBIT) ____

Data Dump Frequency (Per Orbit) ____

Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 1 0 0 0

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed
L,m ______ W,m ______ H,m ______ Deployed
Launch mass, kg 300 - 1000
Consumables Types ______
Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

1) Desire polar sun synchronous orbit for Earth scanning orbits necessary to monitor weather in areas of seismic or drilling/production activity.
2) Real time data downlink at 100MBPS (from free-flyer). 3) Equipment may be sensitive to radio activity and to RF/magnetic fields; equipment may generate RF/magnetic fields. 4) Experiment requires ON/OFF commands from ground (free-flyer).

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1000 ELEMENT NAME GEOLOGICAL RECONNAISSANCE

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1990 INT. HRS ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ______ DAYS TOTAL SERVICES ______

   ☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

   ☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

   EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ______ HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ______ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) 1995 INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. are accounted for in GDCD 172 payload which accommodates the requirements of the payload element.

TOTAL EVA HRS 0

Code: GDCD 1000

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Geological Reconnaissance

Reference Documents:

1. Mobil Research & Development Corporation, USer Fact Sheet

Narrative:

Ref 1 describes a two-phase plan: 1) Station attach for experimental phase; 2) free-flyer for operational phase. The payload element described is the commercial free-flyer.

All data is based on REF 1.

GDCD Payload elements 0174 and 0175 in the Science and Application - Earth Exploration Discipline appear adequate to provide sensors and facility in which experimental development can be conducted. GDCD Payload element 0172 could accommodate the operational needs for Landsat-type data.

PAYLOAD ELEMENT NAME
Remote Atmospheric Sensing

CODE G D C D 1 0 0 1

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 3650

OBJECTIVE

To detect and map atmospheric pollutant concentrations on a real time basis, as well as other weather parameters (clouds, wind) for validating effects of power plant operations and to optimize short term load forecasts for system operation purposes.

TYPE
- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 6

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 2

DESCRIPTION Monitoring atmospheric properties on a real-time basis will enhance system operations by minimizing emissions and optimizing system operations by matching load requirements to power plan commitments in an economical manner. A geosynchronous satellite is envisioned by user for operational phase (described herein), however, instrumentation development by space station could prove cost effective.
Reference GDCD 0262 measurement of atmospheric pollution from satellites (MAPS) could accommodate instrument development.

CODE
G D C D 1 0 0 1

ORBIT CHARACTERISTICS

Apogee, km 35,786 Perigee, km 35,786 Tolerance + -
Inclination, deg 0 Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known)
Pointing accuracy, arc sec Field of view, deg
Pointing Stability (Jitter) arc sec/sec
Special Restrictions (Avoidance) Desire Earth Swaths

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	500 - 1000	
Standby		
Peak		

☐ Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) Frequency (MHZ)
☐ On-Board Data Processing Required
Description
General Purpose Computer

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day
Film (Amount) Voice (Hrs/Day)
Live TV (Hrs/Day) Other
On-Board Storage (MBIT)
Data Dump Frequency (Per Orbit)
Recording Rate (KBPS) Downlink Frequency (MHZ)

CODE G D C D 1 0 0 1

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 300 - 1000

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size ______

Skills (See Table B)

Task Assignment

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Satellite would require geosynchronous transfer orbit placement.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1001 ELEMENT NAME REMOTE ATMOSPHERIC SENSING

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1990 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ____ HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) 2000 INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. are accounted for in GDCD 0262 and 0206 payload which accommodates the requirements of this payload element.

TOTAL EVA HRS 0

Code: GDCD 1001

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Remote Atmospheric Sensing

Reference Documents:

1. Southern California Edison Company, User Fact Sheet.

Narrative:

Ref 1 describes a geosynchronous orbit accommodation for real-time pollutant monitoring. Instrument development for this commercial application could be accommodated on a NASA Science and Applications payload element (GDCD 0262) Measurement of Air Pollution from Satellite (MAPS). The operation satellite would also monitor those weather conditions relative to pollutant monitoring and contributing to optimizing power plant operations. Geostationary Operational Environmental Satellite (GOES) Follow-on GDCD 0206 could provide the desired real-time coverage for this payload element.

The start date for this payload element is estimated; the remaining data is from Ref 1.

PAYLOAD ELEMENT NAME
Cotton Acreage and Production

CODE G D C D 1 0 0 2

TYPE
☐ Science & Applications (non-commercial)
☒ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 6

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days >1825

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 2

OBJECTIVE

Provide more timely and accurate estimates of cotton acreage and production around the world.

DESCRIPTION

The interest would be in providing similar information to that provided by LANOSAT IV more reliability at a lower cost and with greater sophistication. Requirements satisfied by GDCD 0172.

CODE GDCD1002

ORBIT CHARACTERISTICS

Apogee, km 500 Perigee, km 500 Tolerance + 500 - 0
Inclination, deg 45 Tolerance + 45 - 0
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) Desires Swath Across Earth

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 1 0 0 2

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg ______

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1002 ELEMENT NAME COTTON ACREAGE AND PRODUCTION

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1990 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ____ HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) 1995 INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. are accounted for in GDCD 0172 payload which accommodates the requirements of this payload element.

TOTAL EVA HRS 0

Code: GDCD 1002

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Worldwide Cotton Acreage and Production

Reference Documents:

1. Cotton Incorporated, User Fact Sheet

Narrative:

Flight date and orbit altitude data is derived. The remaining data is from Ref 1. NASA Payload element GDCD 0172 Operational Land Systems is adequate to accommodate this payload element requirements.

ORIGINAL PAGE IS
OF POOR QUALITY

PAYLOAD ELEMENT NAME
Petroleum and Mineral Location

CODE G D C D 1 0 0 3

TYPE
- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 6

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 1825

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 3

OBJECTIVE

To locate petroleum and mineral deposits.

DESCRIPTION

New sources for natural resource data will eventually be required. Large focal length cameras and/or high resolution scanners will be required to obtain multispectural images of the Earth's land mass, which will be used to increase knowledge of surface geology and improve exploration efforts for mineral resources.
Objectives accomplished by GDCD 0172.

ORIGINAL PAGE IS
OF POOR QUALITY

CODE G D C D 1 0 0 3

ORBIT CHARACTERISTICS

Apogee, km 920 Perigee, km 920 Tolerance + 10 - 40
Inclination, deg 99.2 Tolerance + 0.7 - 0.2
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec 0.1 Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

CODE G D C D 1 0 0 3

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 30

Consumables Types ______

Acceleration sensitivity, g min ______ max 10^{-2}

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Orbit eccentricity 0.001. Orbit period 103 min; descending node equatorial crossing at 9:30 AM local time. Weight for instruments only. High resolution scanners assumed vs film because of probable service trips needed over the mission duration to retrieve/resupply film.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1003 ELEMENT NAME PETROLEUM AND MINERAL LOCATION

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1990 INT. HRS ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ______

   ☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

   ☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

   EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ____ HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) 1995 INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and. 5 are accounted for in GDCD 0172 payload which accommodates the requirements of this payload element
2. Assumes electronic sensors vs film

TOTAL EVA HRS 0

Code: GDCD 1003

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Petroleum and Mineral Location

Reference Documents:

1. Amoco Production Co., User Fact Sheet

Narrative:

The data is based on Ref 1 that suggests two possibilities for future natural resources data acquisition:

1. Cameras
2. High Resolution Scanners

The High Resolution Scanner approach was selected as most cost effective for the 1990 era to reduce logistic requirements and the probability of multiple service trips by the spacecraft or STS or TMS/OTV to retrieve/resupply film. A free-flyer accommodation was assumed due to the specific orbit paramaters required by the payload element.

The weight of this P/L element is for sensors only, which would be accommodated as part of a Leasecraft-type spacecraft.

Objectives accomplished by 0172.

Section 2.2

Discipline Communications

GDCD ID NO.	PAYLOAD ELEMENT NAME
1100	Small Communication Satellite
1101	Medium Communication Satellite
1102	Large Communication Satellite
1103	Experimental Geo Platform
1104	Operational Geo Platform
1105	Reserved
1106	Large Deployable Antenna
1107	RFI Measurements
1108	Laser Communications
1109	Open Envelope Tube
1110	Spaceborne Interferometer
1111	Millimeter Wave Propagation

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PAYLOAD ELEMENT NAME
Small Communication Satellite

CODE G D C D 1 1 0 0

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☒ Operational
- ☐ Approved
- ☐ Planned
- ☐ Candidate
- ☐ Opportunity

First flight, yr 1990
No. of flights 81
Duration of Flight, days 1

OBJECTIVE

Transfer payload from shuttle, mate it to OTV for transfer and deployment at GEO.

TYPE
- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 7

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

DESCRIPTION Space station will provide an economic benefit. Assuming a space-based OTV is available, multiple communication satellites (delivered to Space Station by Shuttle), will be mated to a single OTV boost stage for transfer and injection into GEO. No servicing or checkout will be performed on these satellites. Number of flights based on 5 to 10 flights per year through 2000.

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CODE G D C D 1 1 0 0

ORBIT CHARACTERISTICS
Apogee, km 35,786 Perigee, km 35,786 ________ Tolerance + ________ - ________
Inclination, deg 0 ________ Tolerance + ________ - ________
Nodal Angle, deg ________ Ephemeris Accuracy, m ________
Escape dV Required, m/s ________

POINTING/ORIENTATION
View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ________
Pointing accuracy, arc sec ________ Field of view, deg ________
Pointing Stability (Jitter) arc sec/sec ________
Special Restrictions (Avoidance) ________

POWER
☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ________ Frequency, Hz ________

DATA/COMMUNICATIONS
Monitoring requirements:
☒ None ☐ Realtime ☐ Offline ☐ Other ________
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ________ Frequency (MHZ) ________
☐ On-Board Data Processing Required
Description ________

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ________
Film (Amount) ________ Voice (Hrs/Day) ________
Live TV (Hrs/Day) ________ Other ________
On-Board Storage (MBIT) ________
Data Dump Frequency (Per Orbit) ________
Recording Rate (KBPS) ________ Downlink Frequency (MHZ) ________

CODE G D C D 1 1 0 0

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☒ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 2 W,m 4.5 H,m 4.5 Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg <816

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2

Skills (See Table B)

Task Assignment | | Payload Manipulation | | | |

SKILL	7	7				
LEVEL	3	2				
Hrs/Day	4	4				

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

1) Sizes and weights can vary considerably within this general group of payloads. These payloads are of a type that might otherwise be placed into GEO with a PAM-D. Crew required only during OTV transfer operations. 2) Power will be self-supported.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1100 ELEMENT NAME SMALL COMMUNICATIONS SATELLITES

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1990 thru 2000 INT. HRS 8 EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ____ HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Task is to transfer satellite to OTV (when available) and verify mating operations (2 men x 4 hrs. = 8 man hours)

TOTAL EVA HRS 0

Code: GDCD 1100

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Small Communications Satellite

Reference Documents:

1. Space Station Study, Commercial Communications Satellites, SPACECOM, Feb. 83, (GDC subcontract)

2. Task II Report Planning Assistance for the 30/20 GHz Program - Worldwide Market Demand Forecast, Western Union Report Sponsored by NASA, June 1981.

3. STS Mission Model 1983-2000, Advanced Planning Division, NASA Headquarters, Dec. 10, 1982

4. Mission Requirements and Network Support Forecast (STDN No. 803), Goddard Space Flight Center, Dec/Jan 1982/1983

5. The Satellite Communications Market in North America, 1982-1991, Frost and Sullivan, July 1981

6. The Market, SPACECOM Study, 4-5/1982 Presentation

7. Space Operations Center Systems Analysis Study Extension, Final Report, Volume I Executive Summary, By Boeing Aerospace, January 1982.

8. Growth and Status of Commercial Communications Satellites, NASA/LeRC, Oct. 15, 1982

9. A 25-Year Forecast for Commercial COMSATS and the Congestion of the Geostationary Arc, Future Systems Inc., Nov. 1977

10. Future of Communications Satellites, STS Users Conference, Sept. 1982, By Goddard Space Flight Center

11. National Space Outlook, National Space Club, June 22-23, 1982

12. Nominal Mission Model, Rev. 6, PS01 MSFC, 30 Sept. 1982.

Narrative:

The method used to estimate commercial communication satellite traffic is documented in Ref 1. References 2-11 contain projections made in various studies and were used as primary sources. Plots of seven principal traffic projections are in Figure 1. Figure 2 presents the two extremes and an average of Figure 1 data. Not all of these data distinguish between satellite sizes.

Table 1 presents traffic projections for three size classes of satellites as made by three separate sources (Ref 9, 7, 3) along with an average. The averages from Figure 2 and Table 1 are essentially equal. Ref 12 and internal analyses were used to validate satellite weights. Lengths were derived based on a modest improvement in density from current satellites. As most of the missions occur in the frame when an OTV is available, kick motors are not included. A more optimum packaging design could be forecast, which would reduce transportation costs.

Separate payload elements are defined for each payload class and identified as small, medium, and large communication satellites.

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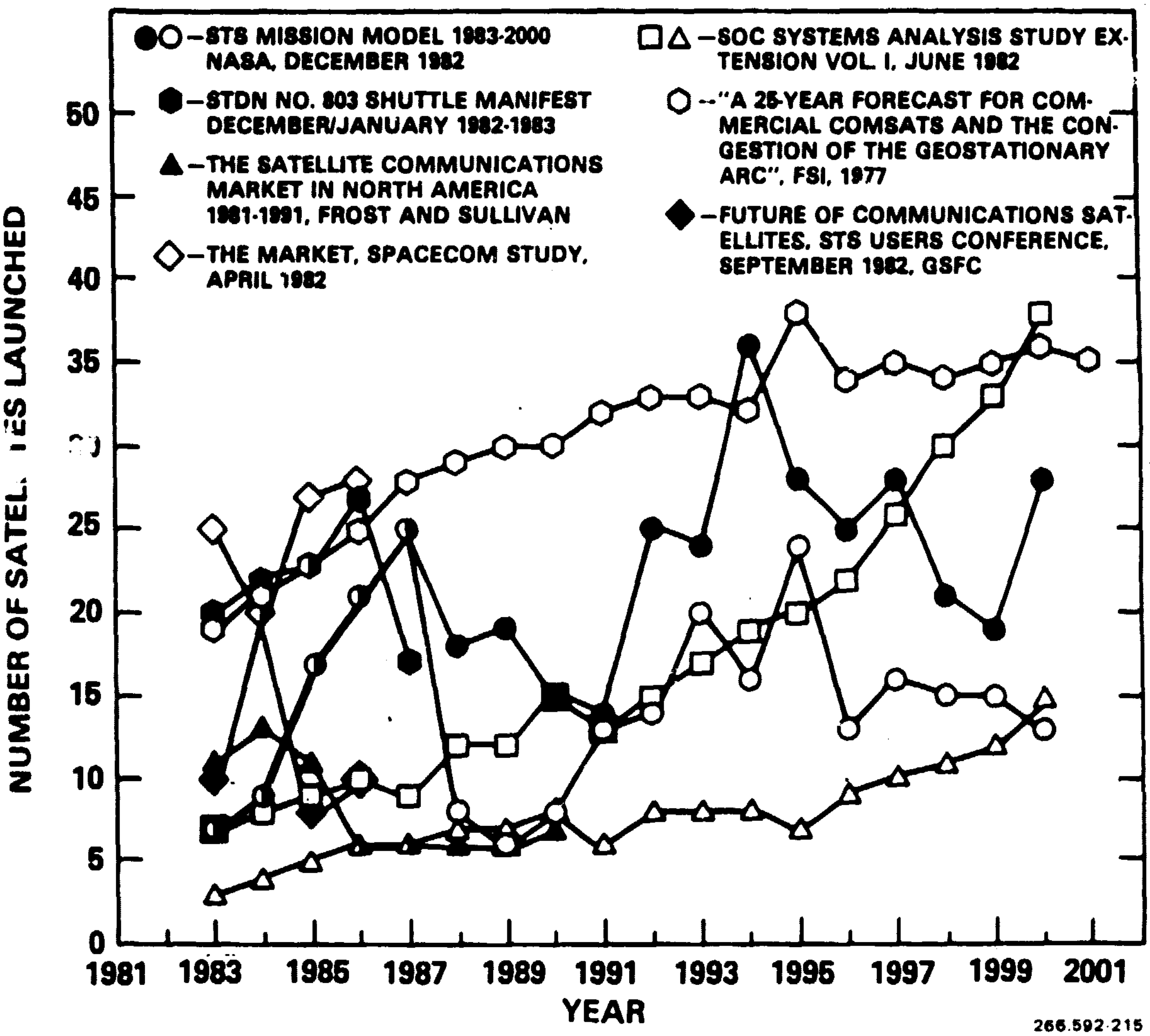

Geosynchronous Launches Reference Summary

Code: GDCD 1100 PAYLOAD ELEMENT SYNTHESIS

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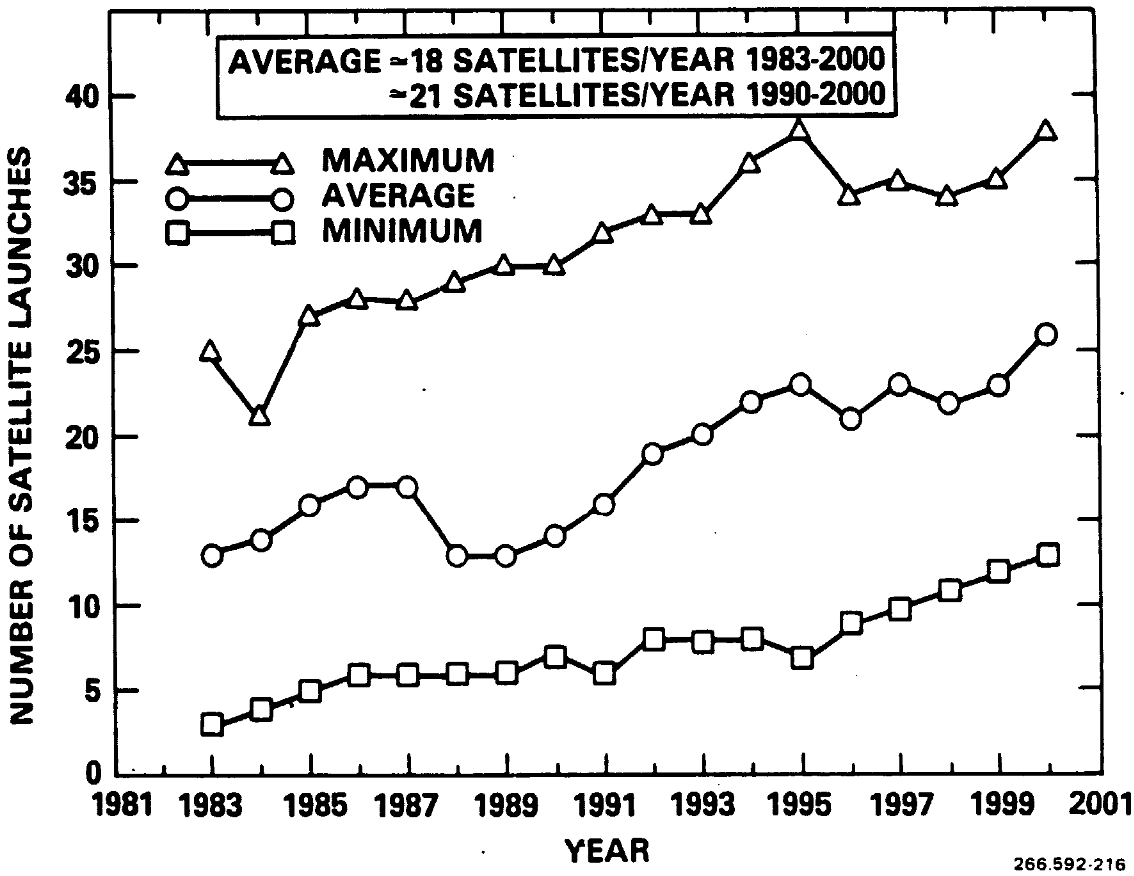

Total Geosynchronous Launches

YEAR	MODEL A			MODEL B			MODEL C			AVG.		
	SMALL	MEDIUM	LARGE	SMALL	MEDIUM	LARGE	SMALL	MEDIUM	LARGE	SMALL	MEDIUM	LARGE
81	–	–	–	5/3*	0	0	–	–	–	4	0	0
82	9	8	0	3/2	0	0	–	–	–	5	4	0
83	10	8	1	5/2	2/1	0	5	0	2	5.5	3	1
84	10	9	2	5/3	3/1	0	7	0	2	6	3	1
85	14	8	1	5/3	3/2	1	17	0	0	10	3	1
86	9	12	4	4/4	4/2	2/0	17	2	2	8.5	5	2
87	12	10	6	0/3	4/3	5/0	21	4	0	9	5	2
88	11	12	6	0/4	3/3	9/0	12/7	3/0	3/1	7	4	4
89	14	10	6	0/3	0/3	12/1	10/6	5/0	4/0	7	4	6
90	11	12	7	0/2	0/5	15/1	10/5	3/2	2/1	6	4	5
91	11	12	9	0	0/5	13/1	9/9	3/1	2/3	6	4	6
92	10	13	10	0	0/5	15/3	20/10	3/2	2/2	8	6	6
93	13	11	9	0	0/5	17/3	22/13	1/4	1/3	10	4	7
94	11	10	11	0	0/1	19/7	26/14	0	10/2	10	3	10
95	11	16	11	0	0	20/7	17/21	3/0	8/3	10	4	10
96	8	13	13	0	0	22/9	12/6	3/0	10/7	5	3	12
97	9	13	13	0	0	26/10	17/11	0	11/5	7	3	13
98	11	11	12	0	0	30/11	12/9	0	9/6	6	3	14
99	8	13	14	0	0	33/12	14/10	0	5/6	6	3	14
00	6	13	17	0	0	38/15	17/10	0	11/3	7	3	17
01	8	13	14	–	–	–	–	–	–	8	13	14
02	7	12	18	–	–	–	–	–	–	7	12	18

SMALL UP TO 1800 lbs. (RCA SATCOM/HUGHES 376 CLASS)
MEDIUM 1900-4500 lbs. (FORD INTELSAT V CLASS)
LARGE 5100 lbs. + (TDRSS CLASS)

*HIGH/LOW MODEL

266.592-217

Satellite Launch Prediction by Mass

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PAYLOAD ELEMENT NAME
Med. Communication Satellite

CODE
G D C D 1 1 0 1

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- [x] Operational
- [ ] Approved
- [ ] Planned
- [ ] Candidate
- [ ] Opportunity

First flight, yr 1990
No. of flights 40
Duration of Flight, days 1

OBJECTIVE

Transfer payload from Shuttle, mate it to OTV for transfer to GEO.

TYPE

- [ ] Science & Applications (non-commercial)
- [x] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A) 7

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

DESCRIPTION

Space station will provide an economic benefit assuming a space based OTV is available, multiple communication satellites (delivered to Space Station by Shuttle) will be mated to a single CTV boost stage for transfer and injection into GEO. No servicing or checkout will be performed on these satellites. Number of flights based on 3 to 6 flights per year through 2000.

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CODE G D C D 1 1 0 1

ORBIT CHARACTERISTICS

Apogee, km 36,786 Perigee, km 36,786 Tolerance + ______ - ______

Inclination, deg 0 Tolerance + ______ - ______

Nodal Angle, deg ______ Ephemeris Accuracy, m ______

Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ______

Pointing accuracy, arc sec ______ Field of view, deg ______

Pointing Stability (Jitter) arc sec/sec ______

Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:

☒ None ☐ Realtime ☐ Offline ☐ Other ______

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______

☐ On-Board Data Processing Required

Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______

Film (Amount) ______ Voice (Hrs/Day) ______

Live TV (Hrs/Day) ______ Other ______

On-Board Storage (MBIT) ______

Data Dump Frequency (Per Orbit) ______

Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

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CODE GDCD1101

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☒ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 4 W,m 4.5 H,m 4.5 Stowed
L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg ≤2041

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2 Task Assignment Payload Manipulation

Skills (See Table B)

SKILL	7	7				
LEVEL	3	2				
Hrs/Day	4	4				

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

1) Sizes and weights can vary considerably within this general group of payloads. These payloads are of a type that might otherwise be placed into orbit with a PAM-A. Crew required only during OTV transfer operations. 2) Power will be self-supplied.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1101 ELEMENT NAME MED COMMUNICATIONS SATELLITES

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1990 thru 2000 INT. HRS 8 EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ____ HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Task is to transfer satellite to OTV (when available) and verify mating operations (2 men x 4 hours = 8 man hours)

TOTAL EVA HRS 0

Code: GDCD 1101

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Medium Communications Satellite

Reference Documents:

1. Space Station Study, Commercial Communications Satellites, SPACECOM, Feb. 83, (GDC subcontract)

2. Task II Report Planning Assistance for the 30/20 GHz Program - Worldwide Market Demand Forecast, Western Union Report Sponsored by NASA, June 1981.

3. STS Mission Model 1983-2000, Advanced Planning Division, NASA Headquarters, Dec. 10, 1982

4. Mission Requirements and Network Support Forecast (STDN No. 803), Goddard Space Flight Center, Dec/Jan 1982/1983

5. The Satellite Communications Market in North America, 1982-1991, Frost and Sullivan, July 1981

6. The Market, SPACECOM Study, 4-5/1982 Presentation

7. Space Operations Center Systems Analysis Study Extension, Final Report, Volume I Executive Summary, By Boeing Aerospace, January 1982.

8. Growth and Status of Commercial Communications Satellites, NASA/LeRC, Oct. 15, 1982

9. A 25-Year Forecast for Commercial COMSATS and the Congestion of the Geostationary Arc, Future Systems Inc., Nov. 1977

10. Future of Communications Satellites, STS Users Conference, Sept. 1982, By Goddard Space Flight Center

11. National Space Outlook, National Space Club, June 22-23, 1982

12. Nominal Mission Model, Rev. 6, PS01 MSFC, 30 Sept. 1982.

Narrative:

The method used to estimate commercial communication satellite traffic is documented in Ref 1. References 2-11 contain projections made in various studies and were used as primary sources. Plots of seven principal traffic projections are in Figure 1. Figure 2 presents the two extremes and an average of Figure 1 data. Not all of these data distinguish between satellite sizes.

PAYLOAD ELEMENT SYNTHESIS

Table 1 presents traffic projections for three size classes of satellites as made by three separate sources (Ref 9, 7, 3) along with an average. The averages from Figure 2 and Table 1 are essentially equal. Ref 12 and internal analyses were used to validate satellite weights. Lengths were derived based on a modest improvement in density from current satellites. As most of the missions occur in the frame when an OTV is available, kick motors are not included. A more optimum packaging design could be forecast, which would reduce transportation costs.

Separate payload elements are defined for each payload class and identified as small, medium, and large communication satellites.

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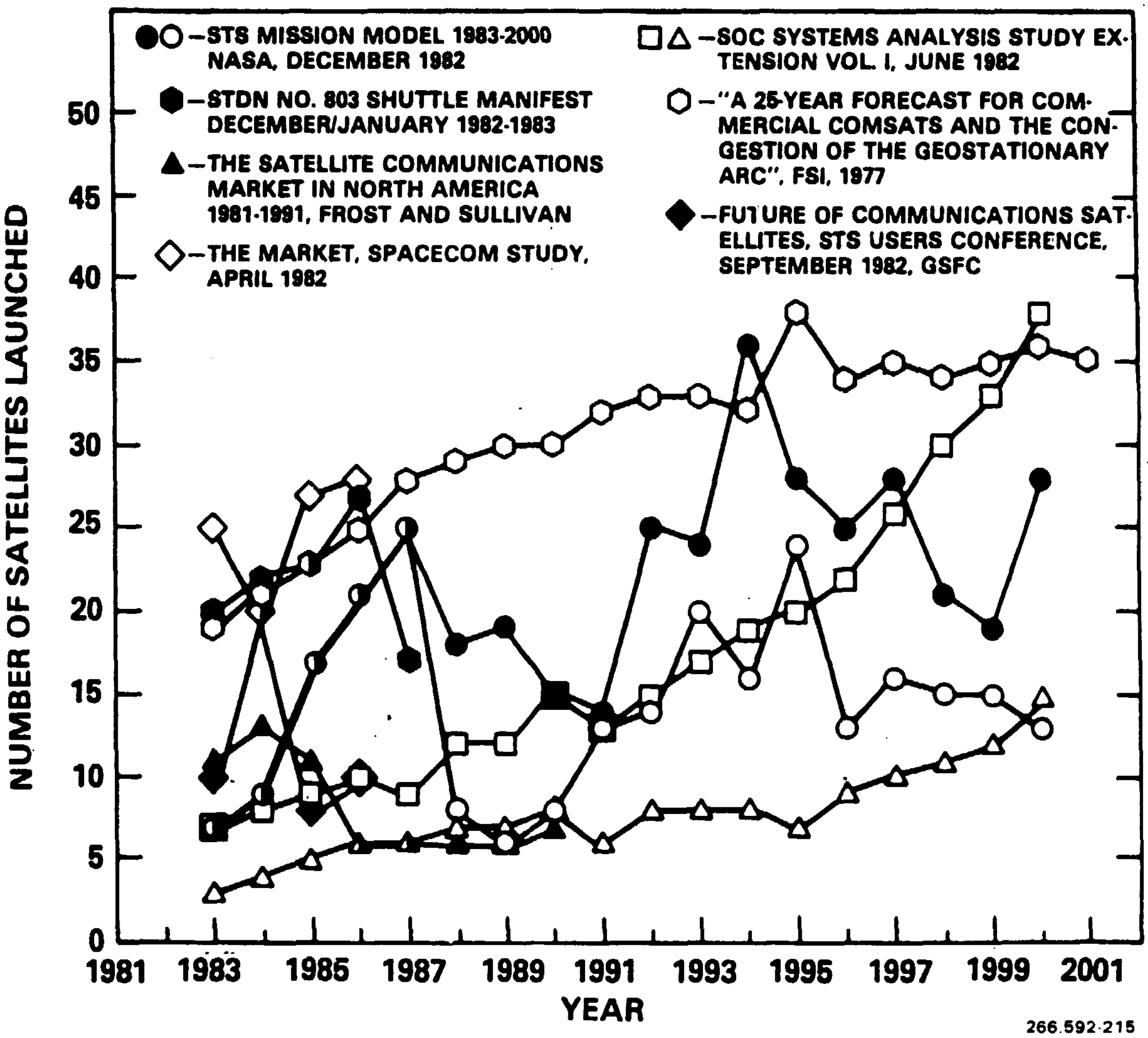

Geosynchronous Launches Reference Summary

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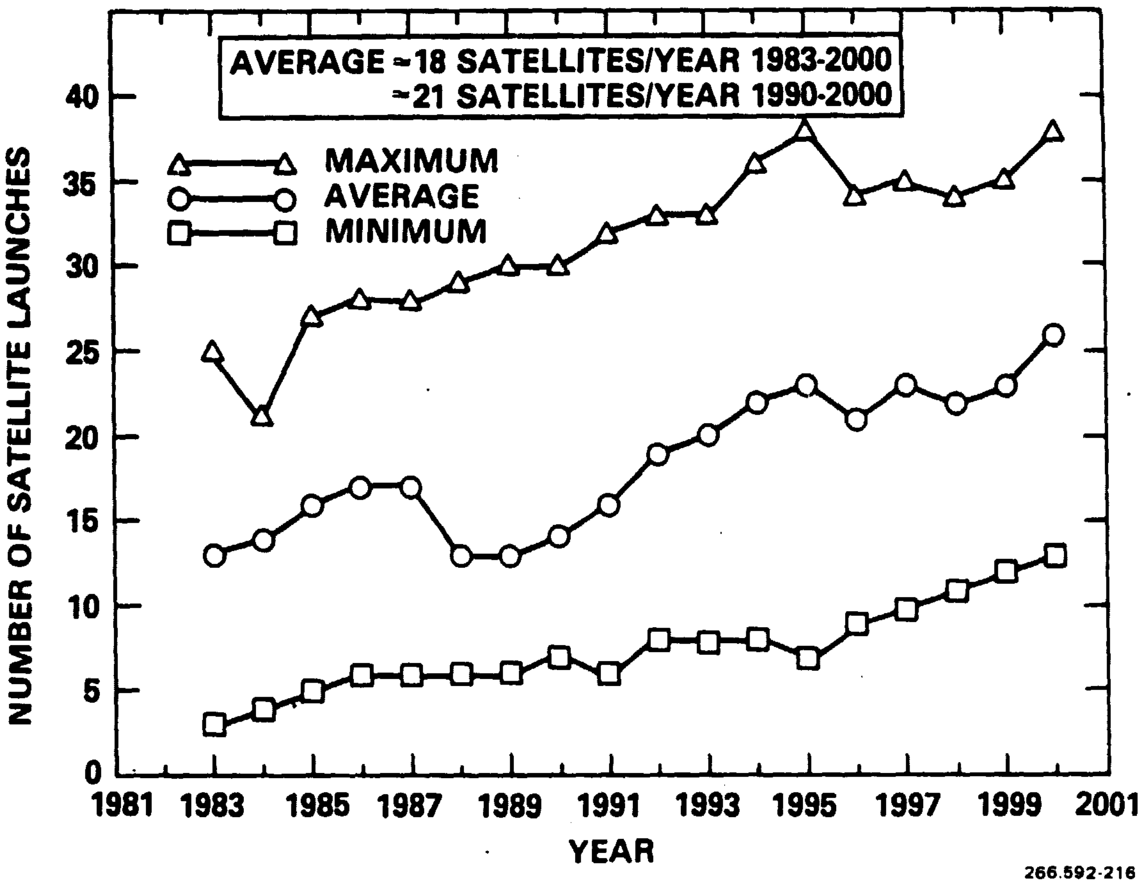

Total Geosynchronous Launches

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YEAR	MODEL A			MODEL B			MODEL C			AVG.		
	SMALL	MEDIUM	LARGE	SMALL	MEDIUM	LARGE	SMALL	MEDIUM	LARGE	SMALL	MEDIUM	LARGE
81	–	–	–	5/3*	0	0	–	–	–	4	0	0
82	9	8	0	3/2	0	0	–	–	–	5	4	0
83	10	8	1	5/2	2/1	0	5	0	2	5.5	3	1
84	10	9	2	5/3	3/1	0	7	0	2	6	3	1
85	14	8	1	5/3	3/2	1	17	0	0	10	3	1
86	9	12	4	4/4	4/2	2/0	17	2	2	8.5	5	2
87	12	10	6	0/3	4/3	5/0	21	4	0	9	5	2
88	11	12	6	0/4	3/3	9/0	12/7	3/0	3/1	7	4	4
89	14	10	6	0/3	0/3	12/1	10/6	5/0	4/0	7	4	6
90	11	12	7	0/2	0/5	15/1	10/5	3/2	2/1	6	4	5
91	11	12	9	0	0/5	13/1	9/9	3/1	2/3	6	4	6
92	10	13	10	0	0/5	15/3	20/10	3/2	2/2	8	6	6
93	13	11	9	0	0/5	17/3	22/13	1/4	1/3	10	4	7
94	11	10	11	0	0/1	19/7	26/14	0	10/2	10	3	10
95	11	16	11	0	0	20/7	17/21	3/0	8/3	10	4	10
96	8	13	13	0	0	22/9	12/6	3/0	10/7	5	3	12
97	9	13	13	0	0	26/10	17/11	0	11/5	7	3	13
98	11	11	12	0	0	30/11	12/9	0	9/6	6	3	14
99	8	13	14	0	0	33/12	14/10	0	5/6	6	3	14
00	6	13	17	0	0	38/15	17/10	0	11/3	7	3	17
01	8	13	14	–	–	–	–	–	–	8	13	14
02	7	12	18	–	–	–	–	–	–	7	12	18

SMALL UP TO 1800 lbs. (RCA SATCOM/HUGHES 376 CLASS)
MEDIUM 1900-4500 lbs. (FORD INTELSAT V CLASS)
LARGE 5100 lbs. + (TDRSS CLASS)

*HIGH/LOW MODEL

266.592-217

Satellite Launch Prediction by Mass

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PAYLOAD ELEMENT NAME
Large Communication Satellite

CODE G D C D 1 1 0 2

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

☐ Operational
☐ Approved
☒ Planned
☐ Candidate
☐ Opportunity

First flight, yr 1990
No. of flights 114
Duration of Flight, days 1

TYPE

☐ Science & Applications (non-commercial)
☒ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 7

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

OBJECTIVE

Transfer payload from Shuttle, mate it to OTV for transfer to GEO.

DESCRIPTION

Space Station will provide an economic benefit. Large satellites will be delivered to the Space Station by Shuttle. Antennas/appendages will be deployed there. These payloads (1 or 2) will then be mated to an OTV if available. Payload checkout will be performed to boost and injection into GEO. Number of flights is based on a range of 5 to 17 flights per year through 2000.

CODE GDCD1102

ORBIT CHARACTERISTICS

Apogee, km 35,786 Perigee, km 35,786 Tolerance + ___ - ___
Inclination, deg 0 Tolerance + ___ - ___
Nodal Angle, deg ___ Ephemeris Accuracy, m ___
Escape dV Required, m/s ___

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ___
Pointing accuracy, arc sec ___ Field of view, deg ___
Pointing Stability (Jitter) arc sec/sec ___
Special Restrictions (Avoidance) ___

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ___ Frequency, Hz ___

DATA/COMMUNICATIONS

Monitoring requirements: /(During Checkout)
☐ None ☒ Realtime ☐ Offline ☐ Other ___
☒ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ___ Frequency (MHZ) C,Ku Bands
☐ On-Board Data Processing Required
Description
Checkout will be controlled by user on ground - station will monitor.

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ___
Film (Amount) ___ Voice (Hrs/Day) ___
Live TV (Hrs/Day) ___ Other ___
On-Board Storage (MBIT) ___
Data Dump Frequency (Per Orbit) ___
Recording Rate (KBPS) ___ Downlink Frequency (MHZ) ___

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CODE GDCD1102

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☒ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 5 W,m 4.5 H,m 4.5 Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg >2313

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 3

Skills (See Table B)

	Task Assignment		Payload Manipulation			
SKILL	7	7	5			
LEVEL	3	2	2			
Hrs/Day	4	4	4			

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

1) Size and weight will vary within this general group of payloads. These payloads are of a size or weight that it will require an OTV equivalent to a Centaur in Shuttle for boost to GEO. Crew required only during OTV handling. 2) Power will be self-supplied.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1102 ELEMENT NAME LARGE COMMUNICATIONS SATELLITES

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1990 thru 2000 INT. HRS 12 EVA HRS ___ EVA CREW ___

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ___ DAYS TOTAL SERVICES ___

   ☐ TMS/OTV REQUIRED ___ STATION HRS PER SERVICE ___

   ☒ NOT APPLICABLE ___ EVA HRS PER SERVICE ___

   EVA CREW SIZE ___

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ___ HRS PER DAY (INTERNAL)

   ___ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ___ DAYS TOTAL RECONFIGS. ___

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ___

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ___

   EVA CREW SIZE ___

5. DEACTIVATION/REMOVAL

   DATE(S) ___ INT. HRS. ___ EVA HRS ___ EVA CREW ___

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Task is to transfer satellite to OTV (when available) and verify mating operations (3 men x 4 hours =12 manhours)

TOTAL EVA HRS 0

Code: GDCD 1102

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Large Communications Satellite

Reference Documents:

1. Space Station Study, Commercial Communications Satellites, SPACECOM, Feb. 83, (GDC subcontract)

2. Tas. II Report Planning Assistance for the 30/20 GHz Program - Worldwide Mai et Demand Forecast, Western Union Report Sponsored by NASA, June 1981.

3. STS Mission Model 1983-2000, Advanced Planning Division, NASA Headquarters, Dec. 10, 1982

4. Mission Requirements and Network Support Forecast (STDN No. 803), Goddard Space Flight Center, Dec/Jan 1982/1983

5. The Satellite Communications Market in North America, 1982-1991, Frost and Sullivan, July 1981

6. The Market, SPACECOM Study, 4-5/1982 Presentation

7. Space Operations Center Systems Analysis Study Extension, Final Report, Volume I Executive Summary, By Boeing Aerospace, January 1982.

8. Growth and Status of Commercial Communications Satellites, NASA/LeRC, Oct. 15, 1982

9. A 25-Year Forecast for Commercial COMSATS and the Congestion of the Geostationary Arc, Future Systems Inc., Nov. 1977

10. Future of Communications Satellites, STS Users Conference, Sept. 1982, By Goddard Space Flight Center

11. National Space Outlook, National Space Club, June 22-23, 1982

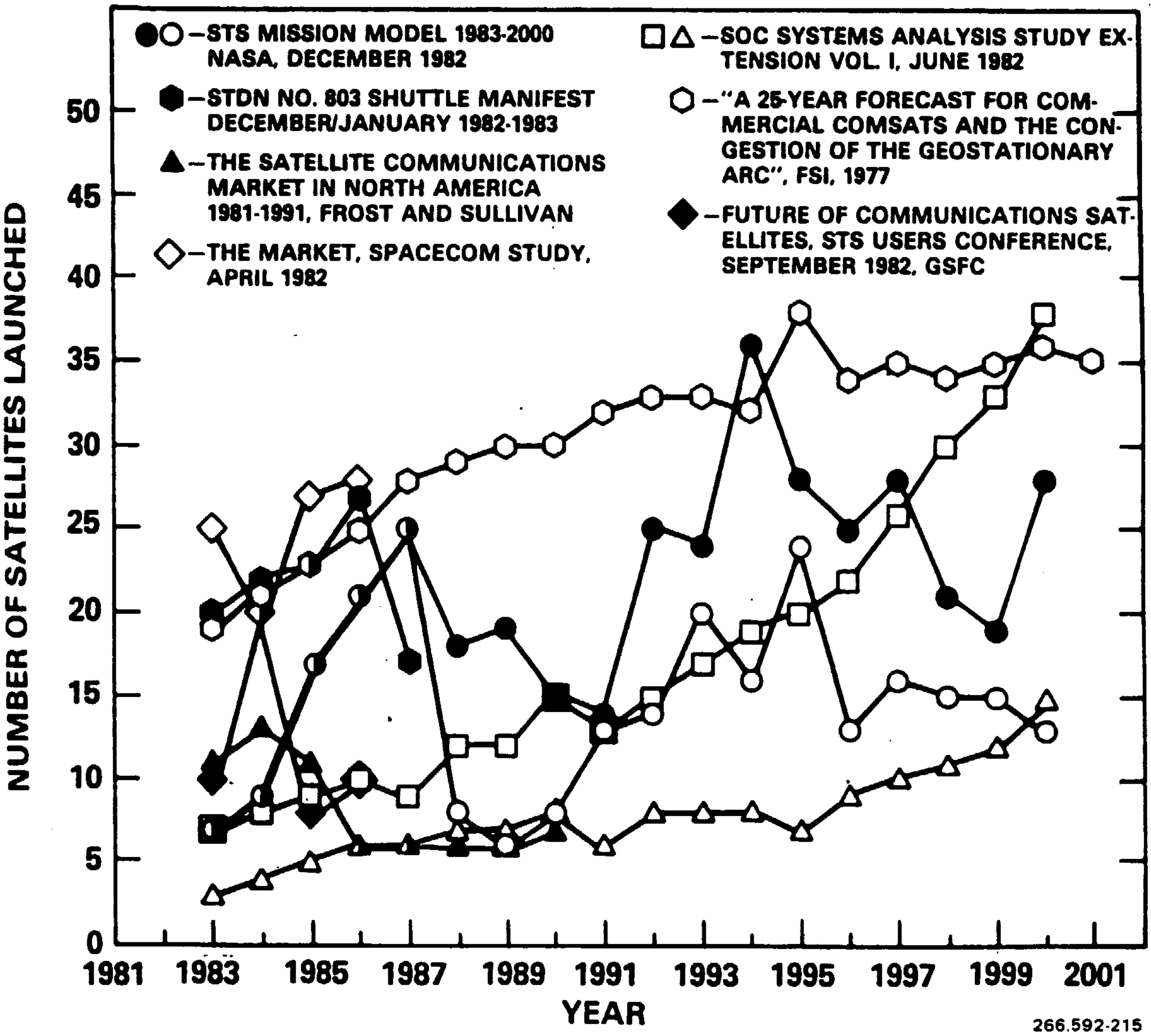
12. Nominal Mission Model, Rev. 6, PS01 MSFC, 30 Sept. 1982.

Narrative:

The method used to estimate commercial communication satellite traffic is documented in Ref 1. References 2-11 contain projections made in various studies and were used as primary sources. Plots of seven principal traffic projections are in Figure 1. Figure 2 presents the two extremes and an average of Figure 1 data. Not all of these data distinguish between satellite sizes.

Table 1 presents traffic projections for three size classes of satellites as made by three separate sources (Ref 9, 7, 3) along with an average. The averages from Figure 2 and Table 1 are essentially equal. Ref 12 and internal analyses were used to validate satellite weights. Lengths were derived based on a modest improvement in density from current satellites. As most of the missions occur in the frame when an OTV is available, kick motors are not included. A more optimum packaging design could be forecast, which would reduce transportation costs.

Separate payload elements are defined for each payload class and identified as small, medium, and large communication satellites.



Geosynchronous Launches Reference Summary

Code: GDCD 1102

PAYLOAD ELEMENT SYNTHESIS

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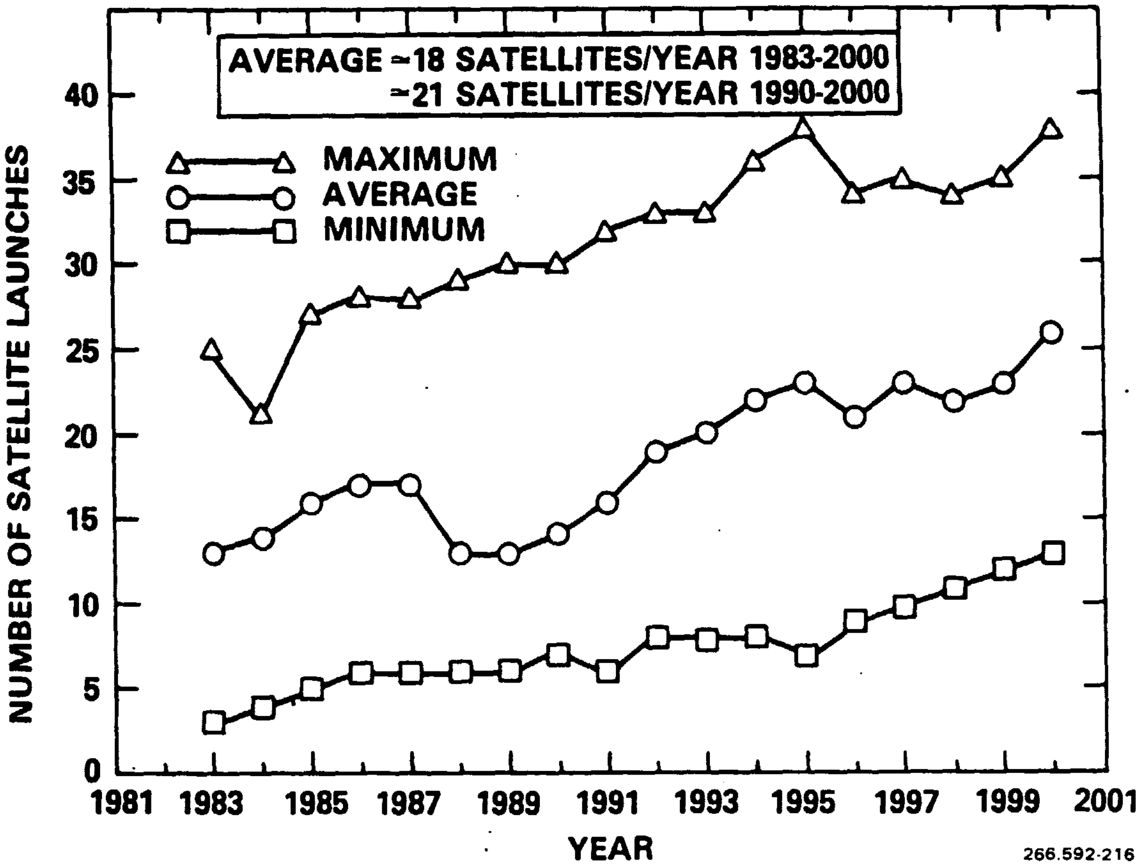

Total Geosynchronous Launches

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YEAR	MODEL A			MODEL B			MODEL C			AVG.		
	SMALL	MEDIUM	LARGE	SMALL	MEDIUM	LARGE	SMALL	MEDIUM	LARGE	SMALL	MEDIUM	LARGE
81	–	–	–	5/3*	0	0	–	–	–	4	0	0
82	9	8	0	3/2	0	0	–	–	–	5	4	0
83	10	8	1	5/2	2/1	0	5	0	2	5.5	3	1
84	10	9	2	5/3	3/1	0	7	0	2	6	3	1
85	14	8	1	5/3	3/2	1	17	0	0	10	3	1
86	9	12	4	4/4	4/2	2/0	17	2	2	8.5	5	2
87	12	10	6	0/3	4/3	5/0	21	4	0	9	5	2
88	11	12	6	0/4	3/3	9/0	12/7	3/0	3/1	7	4	4
89	14	10	6	0/3	0/3	12/1	10/6	5/0	4/0	7	4	6
90	11	12	7	0/2	0/5	15/1	10/5	3/2	2/1	6	4	5
91	11	12	9	0	0/5	13/1	9/9	3/1	2/3	6	4	6
92	10	13	10	0	0/5	15/3	20/10	3/2	2/2	8	6	6
93	13	11	9	0	0/5	17/3	22/13	1/4	1/3	10	4	7
94	11	10	11	0	0/1	19/7	26/14	0	10/2	10	3	10
95	11	16	11	0	0	20/7	17/21	3/0	8/3	10	4	10
96	8	13	13	0	0	22/9	12/6	3/0	10/7	5	3	12
97	9	13	13	0	0	26/10	17/11	0	11/5	7	3	13
98	11	11	12	0	0	30/11	12/9	0	9/6	6	3	14
99	8	13	14	0	0	33/12	14/10	0	5/6	6	3	14
00	6	13	17	0	0	38/15	17/10	0	11/3	7	3	17
01	8	13	14	–	–	–	–	–	–	8	13	14
02	7	12	18	–	–	–	–	–	–	7	12	18

SMALL UP TO 1800 lbs. (RCA SATCOM/HUGHES 376 CLASS)
MEDIUM 1900-4500 lbs. (FORD INTELSAT V CLASS)
LARGE 5100 lbs. + (TDRSS CLASS)

*HIGH/LOW MODEL

266.592-217

Satellite Launch Prediction by Mass

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PAYLOAD ELEMENT NAME
Experimental GEO Platform

CODE G D C D 1 1 0 3

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☒ Planned
- ☐ Candidate
- ☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 5

TYPE

- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 7

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

OBJECTIVE

Remove the platform from Shuttle and mate it to the OTV. Deploy antennas and other appendages as necessary. Perform an integrated checkout and the boost to GEO for deployment.

DESCRIPTION

The experimental GEO platform will be a multi-use platform with its principle function being communication. Some science and applications will also be included. It will be brought to the Space Station by Shuttle where it will be made ready for transfer to GEO. It will be mated to an OTV when antennas and other appendages will be deployed. After a complete check-out it will be boosted at low "g" to GEO. Reference MSFC mission model Rev. 6, 9-30-82.

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CODE
G D C D 1 1 0 3

ORBIT CHARACTERISTICS

Apogee, km 35,786 Perigee, km 35,786 Tolerance + ______ - ______

Inclination, deg 0 ______ Tolerance + ______ - ______

Nodal Angle, deg ______ Ephemeris Accuracy, m ______

Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ______

Pointing accuracy, arc sec ______ Field of view, deg ______

Pointing Stability (Jitter) arc sec/sec ______

Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	______	______
Standby	______	______
Peak	______	______

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements: / (During Checkout)

☐ None ☒ Realtime ☐ Offline ☐ Other ______

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______

☐ On-Board Data Processing Required

Description

Data Type and Rate Dependent on Final Configuration

Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day ______

Film (Amount) ______ Voice (Hrs/Day) ______

Live TV (Hrs/Day) ______ Other ______

On-Board Storage (MBIT) ______

Data Dump Frequency (Per Orbit) ______

Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

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CODE G D C D 1 1 0 3

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☒ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m <10 W,m 4.5 H,m 4.5 Stowed
L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 5,450

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2 Task Assignment 1) Payload Manipulation 2) Checkout

Skills (See Table B)

SKILL	7	5				
LEVEL	3	2				
H. s/Day	4	4				

EVA ☒ YES ☐ NO Reason Deployment Assist Hrs/EVA 15

SERVICING/MAINTENANCE

SERVICE: Interval, days 730 Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

1) This is a one-time mission. There is a revisit scheduled in 1992. If the schedule is met (1990), the Space Station/OTV capability will not be available. 2) Power will be self-supplied. 3) Crew required one time only for 5 days. 4) EVA based on crew of one working 3 Hrs/Day for 5 days. 5) Unmanned servicing revisit at GEO using OTV/TMS, if available.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GOCD CODE 1103 ELEMENT NAME EXPERIMENTAL GEO PLATFORM

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1990 INT. HRS 40 EVA HRS 15 EVA CREW 1

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 730 DAYS TOTAL SERVICES 1

   ☒ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

   ☐ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

   EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ______ HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   ☒ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ______ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Task is to ready platform for GEO launch
   Internal hours based on crew of 2 each working 4 hours/day for 5 days for a total of 40 hours.
   EVA is based on 1 man 3 hours/day for 5 days
2. One in situ service/revisit at GEO assumed

TOTAL EVA HRS 15

Code: GDCD 1103

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Experimental GEO Platform

Reference Documents:

1. Nominal Mission Model, Rev. 6, MSFC PSO1, 30 Sept 1982

Narrative:

The detailed description of this payload was obtained from prior GDC studies. The experimental GEO platform will be a satellite of about 10-12k lb. Consisting of mostly communications (85%) and some multidiscipline experiments (15%). It will be carried by the Shuttle to LEO, where antennas and other appendages will be deployed before it is transferred to GEO (at low thrust) by the OTV.

Ref 1 shows the launch as taking place in 1989; more realistically it will be at least 1990 before the mission is accomplished.

Although listed as a commercial P/L element in accordance with LaRC payload-categorization, this is a NASA provided payload element, per Ref 1.

PAYLOAD ELEMENT NAME
Operational GEO Platform

CODE G D C D 1 1 0 4

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☒ Planned
- ☐ Candidate
- ☐ Opportunity

First flight, yr 1994
No. of flights 11
Duration of Flight, days 5

TYPE
- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 7

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 8

OBJECTIVE

The objective is to construct 2 space platforms over a period of time. One will consist of 5 modules and the other 6, each module the size of the experimental GEO platform. These modules will be delivered by Shuttle to the Space Station and then attached to the OTV for transfer to GEO.

DESCRIPTION

The operational GEO platform will consist of multiple modules, each roughly the size/weight of the experimental GEO platform. The modules will be carried to LEO by the Shuttle, attached to an OTV, and transferred to GEO for assembly and checkout. An alternate method will be to assemble the modules in LEO, checkout the platform, and then use multiple OTVs to lift the platform to GEO. Reference MSFC mission model Rev. 6, 9-30-82.

CODE GDCD1104 Page 2 of 3

ORBIT CHARACTERISTICS

Apogee, km 35,786 Perigee, km 35,786 Tolerance + ___ - ___
Inclination, deg 0 Tolerance + ___ - ___
Nodal Angle, deg ___ Ephemeris Accuracy, m ___
Escape dV Required, m/s ___

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ___
Pointing accuracy, arc sec ___ Field of view, deg ___
Pointing Stability (Jitter) arc sec/sec ___
Special Restrictions (Avoidance) ___

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ___ Frequency, Hz ___

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ___
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ___ Frequency (MHZ) ___
☐ On-Board Data Processing Required
Description
Data Type and Rate To Be Done During Checkout

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ___
Film (Amount) ___ Voice (Hrs/Day) ___
Live TV (Hrs/Day) ___ Other ___
On-Board Storage (MBIT) ___
Data Dump Frequency (Per Orbit) ___
Recording Rate (KBPS) ___ Downlink Frequency (MHZ) ___

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CODE GDCD1104

THERMAL
☐ Active ☐ Passive
Temperature, deg C operational min ______ max ______
non-operational min ______ max ______
Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS
Location: ☐ Internal ☐ External ☒ Remote
Equipment ID/Function ☐ Pressurized ☐ Unpressurized
L,m <10 W,m <4.5 H,m ______ Stowed
L,m ______ W,m ______ H,m ______ Deployed
Launch mass, kg 5450
Consumables Types ______
Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS
Crew Size 1 Task Assignment Platform Checkout and Monitoring
Skills (See Table B)

SKILL	7					
LEVEL	2					
Hrs/Day	4					

EVA ☒ YES ☐ NO Reason Space Construction Hrs/EVA 60

SERVICING/MAINTENANCE
SERVICE: Interval, days 365 Consumables, kg ______
Returnables, kg ______ Man Hours ______
CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

1) Assembly of modules will start in 1992, with revisits scheduled to start in 1995. Eight revisits are scheduled. Crew required twice per year, 5 days per operation. 2) Physical characteristics are per module. 3) Power is self-supplied during checkout. 4) EVA is based on crew of 2 working 6 Hrs/Day for 5 days for each of 11 flights. 5) Total of 8 servicing revisits, unmanned, to year 2000.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1104 ELEMENT NAME OPERATIONAL GEO PLATFORM

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1994 thru 2000 INT. HRS 20 EVA HRS 60 EVA CREW 2

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL VARIABLE DAYS TOTAL SERVICES VARIABLE

☒ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

☐ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

______ HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☒ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Internal hours based on 4 hours/day for 5 days
   EVA hours based on crew of 2 working hours/day for 5 days
2. One service/revisit every year 1995 and on through 2000.
   2 revisits planned in 1997 and 2000 (8 total)

TOTAL EVA HRS 60 per flight

Code: GDCD 1104 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Operational GEO Platform

Reference Documents:

1. Nominal Mission Model, Rev. 6, MSFC PS01, 30 Sept. 1982

Narrative:

The detailed description of these payloads was obtained from prior GDC studies. There will be two platforms, one consisting of five modules and the other six modules. Each module will require an OTV flight to GEO, where it will be mated with the other modules. Each module will be roughly the size and weight of the experimental GEO platform.

Although listed as a commercial payload element in accordance with LaRC payload categorization; the first two platform modules will be provided as NASA payload elements per Ref 1.

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PAYLOAD ELEMENT NAME
Large Deployable Antenna

CODE G D C D 1 1 0 6

TYPE
- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 7

CONTACT
Name: W. Hardy/' Peterson MZ 21-9530
Address: General . namics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1992
No. of flights 2
Duration of Flight, days 14

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 9

OBJECTIVE 1) Develop the technology for deploying large (>15 m diameter) communications satellite antennas and associated feeds; 2) demonstrate new deployment techniques; 3) measure static and dynamic mechanical properties, including surface accuracy; 4) determine effects of the space environment on antenna structure; and 5) measure electrical performance.

DESCRIPTION A variety of configurations and a large range of experimental parameters and activities may be proposed. Reflectors, horns, arrays, lenses, and other types of antennas may be considered. The erectable antennas may have deployed dimensions from 15 to 100 m. They may be unfolded, unrolled, inflated, extended, or assembled from separately launched components. Reflectors, horns and other large antennas that require precise mechanical tolerances will need a large number of measurements to determine the mechanical performances in space; whereas arrays or antennas that can be tuned, adapted, and controlled electrically may not need elaborate measurements of the mechanical performances.
Second flight in 1994. Payload could be classified as technology development.

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CODE
G D C D 1 1 0 6

ORBIT CHARACTERISTICS

Apogee, km Any Perigee, km Any Tolerance + -
Inclination, deg Any Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) TBD in continental U.S.
Pointing accuracy, arc sec 360 Field of view, deg 20
Pointing Stability (Jitter) arc sec/sec
Special Restrictions (Avoidance) Antenna Blockage

POWER

☐ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	200	
Standby	50	
Peak	300	

☐ Continuous

Voltage, V 28 Frequency, Hz NA

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) Frequency (MHZ)
☐ On-Board Data Processing Required
Description
Probable test results data rate of 200 - 400 kbps.

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day
Film (Amount) 5 minutes for deployment Voice (Hrs/Day)
Live TV (Hrs/Day) 5 minutes during deployment Other
On-Board Storage (MBIT)
Data Dump Frequency (Per Orbit)
Recording Rate (KBPS) 400 Downlink Frequency (MHZ) Experiment Dependent

ORIGINAL PAGE IS
OF POOR QUALITY

CODE G D C D 1 1 0 6

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☒ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 25 W,m 5 H,m 3 Stowed

L,m 50 W,m 20 H,m 50 Deployed

Launch mass, kg 500

Consumables Types ______

Acceleration sensitivity, g min ______ max 6

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL	5					
LEVEL	3					
Hrs/Day	0.5					

EVA ☒ YES ☐ NO Reason Const/Measurements Hrs/EVA 40

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

A stowed antenna will be carried to the SS via Shuttle. It will be placed in an external location such that when deployment actuation via astronaut command from SS is made, the antenna will point toward the earth. When the experiments are completed, the antenna should be refolded and returned to Earth on a Shuttle or put into a controlled reentry orbit.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1106 ELEMENT NAME LARGE DEPLOYABLE ANTENNA

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S)	INT. HRS	EVA HRS	EVA CREW
1992	5	10	2
1994	3	10	2

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ______ DAYS TOTAL SERVICES ________

☐ TMS/OTV REQUIRED ________ STATION HRS PER SERVICE ________

☒ NOT APPLICABLE ________ EVA HRS PER SERVICE ________

EVA CREW SIZE ________

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

.5 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ________

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ________

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ________

EVA CREW SIZE ________

5. DEACTIVATION/REMOVAL

DATE(S)	INT. HRS.	EVA HRS	EVA CREW
1992		10	2
1994		10	2

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. EVA req. for construction assist and surface measurement.
3. OP support req. for 2 periods of 14 days each for performance monitoring (28 days total)
5. Ready for earth return

TOTAL EVA HRS 40

Code: GDCD 1106

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Large Deployable Antenna

Reference Documents:

Supplied by SPACECOM under subcontract to GDC

Narrative:

The Space Station would provide the "bus" housing and support for the undeployed antenna brought to orbit by the shuttle. The antenna would be placed on the station where it could be observed during the deployment sequence. If communications experiments are to be conducted with the antenna, such as RFI, then the station would provide electrical power, a stable platform, and a location for the RF equipment.

The astronauts would have the responsibility to set up the experiment, position the antenna on the station, photograph the antenna deployment, perform the surface accuracy measurements employing RF or laser scanning techniques and conduct communications or RFI measurements with the antenna. When the antenna experiment is completed, the astronaut is to cut the antenna from the station or refurl the antenna for return to earth via the shuttle.

PAYLOAD ELEMENT NAME
RFI Measurements

CODE G D C D 1 1 0 7

CONTACT
Name W Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1994
No. of flights 1
Duration of Flight, days 21

TYPE

- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 7

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 7

OBJECTIVE

To characterize and identify a single source of known RF transmission (from 100 MHz and higher) originating from the Earth in the space allocated bands, and demonstrate the ability to locate (within 5 km) such transmissions.

DESCRIPTION

Employ a low-noise receiver connected to a large (>15 m diameter), earth-pointing antenna having a "zoom" capability to receive RF signals from Earth. A calibrated spectrum analyzer is then used to determine frequency, power level and spectral characteristics of the received signal. Several different antenna feeds and receiving equipments are required to characterize the RFI.

First flight 1994 with full time unit operational in approximately 6 years.

CODE GDCD1107

ORBIT CHARACTERISTICS

Apogee, km Any Perigee, km Any Tolerance + ____ -
Inclination, deg Any Tolerance + ____ -
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) in continental U.S.
Pointing accuracy, arc sec 3600 Field of view, deg Near Hemispherical
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	100	
Standby	25	
Peak	300	

☒ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☒ On-Board Data Processing Required
Description Rev and analyze spectral info and produce data for xmsn to Earth (200 KBPS).

Data Types: ☐ Analog ☒ Digital ☒ Hrs/Day 24
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) TBD
Data Dump Frequency (Per Orbit) Continuous to TDRSS
Recording Rate (KBPS) 1000 Downlink Frequency (MHZ) ____

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OF POOR QUALITY

CODE G D C D 1 1 0 7

THERMAL

[X] Active [ ] Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: [X] Internal [X] External [ ] Remote

Equipment ID/Function [ ] Pressurized [ ] Unpressurized

L,m >15	W,m 2	H,m 2	Stowed
L,m >15	W,m >15	H,m >15	Deployed

Launch mass, kg 50

Consumables Types 0

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1 Task Assignment Monitoring

Skills (See Table B)

SKILL	5					
LEVEL	3					
Hrs/Day	0.5					

EVA [X] YES [ ] NO Reason Change Feeds Hrs/EVA 4

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day 7 Man/Hrs Req. 4
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

RFI monitoring over certain foreign countries may be sensitive.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1107 ELEMENT NAME RFI MEASUREMENTS

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1994 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.5 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 7 DAYS TOTAL RECONFIGS. 2

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 2

☐ NOT APPLICABLE EVA HRS PER RECONFIG. 2

EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

DATE(S) 1994 INT. HRS. ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Station OPS
3. Continuous monitoring for 21 days.
4. Change feeds
5. Station OPS

TOTAL EVA HRS 4

Code: GDCD 1107

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: RFI Measurements

Reference Documents:

Supplied by SPACECOM under subcontract to GDC

Narrative:

A need exists to be able to detect and measure the signal strength of terrestrial-based radio emissions operating out of band or transmitting higher than permitted signal levels. The FCC attempts to monitor these emmissions by ground-based vehicles. A low-altitude satellite containing a sensitive receiver and high G/T antenna should be capable of detecting sources of terrestrial transmissions in frequency bands of interest, determine its spectral signature and antenna pattern and locate the source (to a few kilometers). To accomplish this experimental test, a large antenna having a "zoom" capability to narrow its beam coverage will be required, plus a low noise receiver and a spectrum analyzer. The antenna should have a capability to operate within a frequency range from 100 MHz to 30 GHz.

A scientist-astronaut on the Space Station can aid this experiment by setting up the antenna, change feeds when required, operate the zoom feature of the antenna, observe the spectral data, and verify the interfering source's location on the earth.

PAYLOAD ELEMENT NAME
Laser Communications

CODE G D C D 1 1 0 8

TYPE
- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 7

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1991
No. of flights 2
Duration of Flight, days 5

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 7

OBJECTIVE

To develop the technology and demonstrate performance for inter-satellite data transfer, at near megabit data rates, employing laser optics and CO_2NdYAG or TBD gases.

DESCRIPTION

A laser transmitter and receiving system is delivered to the SS and installed with an inertial pointing system (IPS) in a location providing near hemispheric coverage. On a later Shuttle flight or launch of a subsatellite, a second laser transmitter and/or receiver is in space. The Shuttle or subsatellite must back away a sufficient distance (hundreds of miles) to perform track, acquisition, lock-up and transmission and reception of data between the two laser systems. Bit error rates will be measured. Time to reacquire communications, if interrupted, will be determined. Two experiments, 1 per year 1991 and 1992.

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CODE GDCD1108

ORBIT CHARACTERISTICS

Apogee, km Any Perigee, km Any Tolerance + -
Inclination, deg Any Tolerance + -
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☒ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) NA
Pointing accuracy, arc sec 360 Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) Near Hemispheric Coverage

POWER

☐ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	200	3
Standby	50	0.5
Peak	500	20.5

☐ Continuous

Voltage, V 28 Frequency, Hz TBD

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) TBD Frequency (MHZ) TBD
☐ On-Board Data Processing Required
Description
Probable data rate 1 GBPS.

Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day ____
Film (Amount) 5 minutes Voice (Hrs/Day) No
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) Up to 1000
Data Dump Frequency (Per Orbit) TDRSS Compatible
Recording Rate (KBPS) 100,000 Downlink Frequency (MHZ) ____

CODE G D C D 1 1 0 8 **Page 3 of 3**

THERMAL

[X] Active [X] Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: [ ] Internal [X] External [ ] Remote

Equipment ID/Function [ ] Pressurized [ ] Unpressurized

L,m 2 W,m 1 H,m 1 Stowed

L,m 2 W,m 1 H,m 1 Deployed

Launch mass, kg 140

Consumables Types 0

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1

Skills (See Table B) Task Assignment ______

SKILL	5					
LEVEL	3					
Hrs/Day	0.5					

EVA [X] YES [ ] NO Reason Set-Up/Disassembly Hrs/EVA 5

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Signal acquisition between the SS-carried laser and another spacecraft carrying a laser payload must be achieved. This will require a fine pointing system and a near hemispheric coverage. SS laser should be returned to Earth.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GOCD CODE 1108 ELEMENT NAME LASER COMMUNICATIONS

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S)	INT. HRS	EVA HRS	EVA CREW
1991	2.5	2.5	1
1992	2.5	2.5	1

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ______ DAYS TOTAL SERVICES ______

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.5 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S)	INT. HRS.	EVA HRS	EVA CREW
1991	2.5	2.5	1
1992	2.5	2.5	1

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Set up laser
3. Two flights, 5 days each, 0.5 hr./day
5. Remove equipment

TOTAL EVA HRS 5 (per flight)

Code: GDCD 1108

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Laser Communications

Reference Documents:

Supplied by SPACECOM under subcontract to GDC

Narrative:

Space Station offers a unique opportunity to develop the technology for space-to-space, very high data rate communications employing lasers. Competing laser technologies, such as CO_2 and NdYAG can be tested and results compared for signal/noise, bit error rate, sensitivity to jitter and capability to lock-on to a receiver or transmitter.

The approach to the conduct of a laser intersatellite test requires that an optical receiving system be located some distance from the Space Station-based laser transmitter. This can be accomplished by the deployment of a suitable equipped subsatellite from the Space Shuttle, use of a shuttle-based pallet or cooperation with some other laser receiver equipped satellite, U.S. or international. The Space Station will house an instrument pointing system for the laser transmitter which should have an accuracy of better than 0.5 degree.

The astronaut-scientist on the station will be responsible for attaching the laser package to the pointing system and power supply, seeing that the equipment is operating, assist in calibrating the instrument, point it in the correct direction and observe that lock-up has occurred and that data is flowing.

PAYLOAD ELEMENT NAME
Open Envelope Tube

CODE G D C D 1 1 0 9

TYPE
- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 7

CONTACT
Name / Address: W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1993
No. of flights 2
Duration of Flight, days 7

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

OBJECTIVE

To determine the feasibility of operating high-power, RF, amplifier tubes which are open to the space environment in the vicinity of a spacecraft located outside of the Earth's atmosphere.

DESCRIPTION The experiment would consist of measuring the performance of several tubes before and after opening the vacuum envelopes and then resealing and returning the tubes to an earth laboratory. One technique suitable for unsealing and resealing the vacuum envelope in space is to use a meltable gasket of indium. Tube operating heat would be sufficient to melt the indium before separation of the collector cover. Removal of tube power would reseal the tube after the cover is replaced. After return to Earth the internal content of some tubes would be analyzed while others would be life tested and compared with tubes that were not opened to space. The in-orbit procedure would be to place one tube at a time on an extendable boom, operate the tube and then return the tube to the Space Station interior.
Two experiments per year/1993 and 1994.

CODE G D C D 1 1 0 9

ORBIT CHARACTERISTICS

Apogee, km Any Perigee, km Any Tolerance ± ____
Inclination, deg Any Tolerance ± ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☒ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) NA
Pointing accuracy, arc sec NA Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) None

POWER

☐ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	500	
Standby	200	
Peak	2000	

☐ Continuous

Voltage, V 28 Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☒ On-Board Data Processing Required
Description
50-100 KBPS

Data Types: ☐ Analog ☒ Digital ☒ Hrs/Day 24
Film (Amount) Photos Voice (Hrs/Day) ____
Live TV (Hrs/Day) None Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) TDRSS Compatible
Recording Rate (KBPS) 100 Downlink Frequency (MHZ) Ku/Ka-Band

CODE G D C D 1 1 0 9

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 0.2 W,m 0.2 H,m 2 Stowed
L,m 0.2 W,m 0.2 H,m 6 Deployed

Launch mass, kg 157

Consumables Types 0

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1

Skills (See Table B)

Task Assignment ______

SKILL	5					
LEVEL	3					
Hrs/Day	0.25					

EVA ☒ YES ☐ NO Reason Install/Remove Hrs/EVA 4

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

A number of open envelope tubes will be brought to the SS to be deployed on an extendible boom away from the SS body (to avoid contamination).

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1109 ELEMENT NAME OPEN ENVELOPE TUBE

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S)	INT. HRS	EVA HRS	EVA CREW
1993	2	2	1
1994	2	2	1

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.25 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S)	INT. HRS.	EVA HRS	EVA CREW
1993	2	2	1
1994	2	2	1

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Set up plus station OPS
3. 2 experiments, 7 days each with .25 hours/day req.
5. Station OPS

TOTAL EVA HRS 4 (per flight)

Code: GDCD 1109 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Open Envelope Tube

Reference Documents:

Supplied by SPACECOM under subcontract to GDC

Narrative:

A major technical problem to the development of long life, high performance space communications electronic tubes is the deterioraztion of the vacuum inside the tube envelope caused by outgassing, overheating, barium deposition, or insulators and onput window cracking due to thermal stresses. One concept to maintain vacuum is to utilize the infinite pumping capacity of space by opening the tube to the space vacuum. Such a tube could be redesigned for simpler fabrication by eliminating the ion pump employed to maintain vacuum and the removal of output waveguide windows.

Space Station affords the communications engineer the opportunity to test a number of competing techniques for tube envelope removal in space. The tube should be placed on an extendible boom and deployed at a distance from the station to avoid any contamination. An electrical command from the astronaut will "blow" the cover. Tube operating characteristics and temperature distribution in the collector will be measured and transmitted to earth.

PAYLOAD ELEMENT NAME
Spaceborne Interferometer

CODE G D C D 1 1 1 0

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 1995
No. of flights 2
Duration of Flight, days 15

TYPE

☐ Science & Applications (non-commercial)
☒ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 7

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

OBJECTIVE

To develop the spaceborne technology of providing position locations of mobile platforms (ships, aircraft, etc.) using a single satellite.

DESCRIPTION Angle measurement via the interferometer technique requires mutually perpendicular, long baseline antennas. Employing the L-band frequency would require antenna separation of about 40 meters. Each interferometer consists of antennas on booms extending out from the SS, plus electronics for amplifying, frequency shifting, and combining the received signals for retransmission to the ground where phase measurements are performed. Antenna separation distance must be accurately known. A total of 4 RF subelements are required. Fixed platforms, whose location is known to within ±5km, will transmit signals to the SS, when it comes within view. Knowledge of the SS location, phase measurements from the interferometer and distance from SS to platform provide data to give the location of the fixed or moving platform. Second flight in 1997. Payload could be classified as Technology Development.

CODE G D C D 1 1 1 0

ORBIT CHARACTERISTICS

Apogee, km Any Perigee, km Any Tolerance + -

Inclination, deg Any Tolerance + -

Nodal Angle, deg ______ Ephemeris Accuracy, m ±100

Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth

Truth Sites (if known) Within continental U.S. Location known to ±5 km.

Pointing accuracy, arc sec 360 Field of view, deg Near Hemispherical

Pointing Stability (Jitter) arc sec/sec ______

Special Restrictions (Avoidance) ______

POWER

☐ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	100	2
Standby	25	
Peak	150	0.5

☐ Continuous

Voltage, V 28 Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☒ Realtime ☐ Offline ☐ Other ______

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______

☐ On-Board Data Processing Required No

Description

Proposed data rate from Space Station = 300-500 KBPS.

Data Types: ☐ Analog ☒ Digital ☒ Hrs/Day 2.0

Film (Amount) Movie & Photos Voice (Hrs/Day) ______

Live TV (Hrs/Day) ______ Other ______

On-Board Storage (MBIT) ______

Data Dump Frequency (Per Orbit) TDRSS Compatible

Recording Rate (KBPS) 500 Downlink Frequency (MHZ) ______

CODE GDCD1110

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☒ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 5 W,m 0.6 H,m 0.6 Stowed

L,m 30 W,m 0.2 H,m 0.2 Deployed

Launch mass, kg 60

Consumables Types 0

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1

Skills (See Table B)

Task Assignment ______

SKILL	5					
LEVEL	3					
Hrs/Day	0.5					

EVA ☒ YES ☐ NO Reason Set-Up/Remove Hrs/EVA 16

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

The effect of boom deflections is important to determining the technical practicality of this experiment, since boom movement causes phase changes to the interferometer, which changes the position location accuracy.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GOCD CODE 1110 ELEMENT NAME SPACE BORNE INTERFEROMETER

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S)	INT. HRS	EVA HRS	EVA CREW
1995	8	8	1
1997	8	8	1

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.5 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S)	INT. HRS.	EVA HRS	EVA CREW
1995	8	8	1
1997	8	8	1

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Set up plus station OPS
3. Based on flights in 1995 and 1997 of 15 days each with .25 hours/day required.
5. Station OPS

TOTAL EVA HRS 16 (per flight)

Code: GDCD 1110

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Spaceborne Interferometer

Reference Documents:

Supplied by SPACECOM under subcontract to GDC

Narrative:

The spaceborne interferometer is a space station system using widely spaced antennas to track various moving platforms such as airplanes, ships, balloons, bouys, etc.

This feature could provide an air traffic control or ship coordination application.

The technology for space-based interferometers needs to be developed and demonstrated. Potential technical problems of boom deflection and spacecraft jitter and stabilization on the location accuracy must be tested. Space Station affords the opportunity to develop the techniques and demonstrate the position determination accuracy of interferometers.

Booms of varying length and antennas with different RF feeds could be housed on Space Station to demonstrate different applications. Aircraft and ship positioning should use the 1.5 GHz band, while search and rescue and data collection would use the 401-406 MHz band. The astronauts would install the antenna and feed booms at the ends of Space Station elements to form a long, crossed-baseline interferometer. They would periodically inspect the antenna and electronics for proper operations.

PAYLOAD ELEMENT NAME
Millimeter Wave Propagation

CODE G D C D 1 1 1 1

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 1991
No. of flights 3
Duration of Flight, days 5

TYPE

☐ Science & Applications (non-commercial)
☒ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 7

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 6

OBJECTIVE

To provide propagation data needed for future communications satellite services at frequencies assigned by recent international meetings (WARC-79), above 30 GHz.

DESCRIPTION A dish-type antenna plus a single channel transmitter will be placed on the SS to work with ground receive terminals placed at pre-selected sites within the U.S. and in foreign countries. Various EIRP levels will be transmitted from the SS for reception at the ground. Carrier-to-noise, bit error rate, and signal-to-noise measurements will be taken, as a function of EIRP, and environmental conditions (rain, fog, snow). Two experiments in the early 1990's followed by full time propagation starting in 1993.
Five days each for 2 experiments; 2920 days for continuous monitoring (3rd launch).

CODE G D C D 1 1 1 1

ORBIT CHARACTERISTICS

Apogee, km Any Perigee, km Any Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m NA
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☒ Earth
Truth Sites (if known) TBD
Pointing accuracy, arc sec 3600 Field of view, deg Near Hemispherical
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	25	
Standby	10	
Peak	100	

☐ Continuous

Voltage, V 28 Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) Photos Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) Above 30 GHz

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CODE G D C D 1 1 1 1

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☒ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 3 W,m 0.5 H,m 3 Stowed

L,m 3 W,m 0.5 H,m 3 Deployed

Launch mass, kg 40

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1 Task Assignment ______

Skills (See Table B)

SKILL	5					
LEVEL	3					
Hrs/Day	0.25					

EUA ☒ YES ☐ NO Reason Install/Service/Rem Hrs/EVA 4

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg 0

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day 1460 Man/Hrs Req. 4

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Reconfiguration involves adjusting/changing frequency producing module in pressurized volume.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GOCD CODE 1111 ELEMENT NAME MILLIMETER WAVE PROPAGATION

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S)	INT. HRS	EVA HRS	EVA CREW
1991	2.0	2.0	1
~~1992~~	~~2.0~~	~~2.0~~	~~1~~
~~1993~~	~~2.0~~	~~2.0~~	~~1~~

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ______ DAYS TOTAL SERVICES ______

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.25 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. 1

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 2

☐ NOT APPLICABLE EVA HRS PER RECONFIG. 2

EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

DATE(S)	INT. HRS.	EVA HRS	EVA CREW
1991	2.0	2.0	1
1992	2.0	2.0	1

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Set up plus station OPS
3. 2 flights, 1991 and 1992, 5 days each with .25 hrs/day. Relaunch in 1993 with continuous monitoring and adjustments from 1993-2000, 0.25 hr/day.
4. Reconfig. for 1993 (launch only)
5. Station OPS for 1991 and 1992 launches. Launch in 1993 continues after year 2000 and does not require deactivation

TOTAL EVA HRS 4 (per flight)

Code: GDCD 1111

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Millimeter Wave Propagation

Reference Documents:

Supplied by SPACECOM under subcontract to GDC

Narrative:

The 1979 World Administrative Radio Conference (WARC) assigned new frequency bands for future comsat applications and research needs in the millimeter waveband (30-300 GHz). Prior to use of these bands for space applications and communications, the basic characteristics of the frequency band is required, such as: effects on the signal due to fog, rain, snow, elevation angle, and terrain. The performance data of the various new RF components, antenna, and antenna feeds are also to be obtained. Some of the bands of interest to comsat developers and users are: Broadcast - 41.5 and 48.5 GHz; Mobile-40 and 51 GHz; and Fixed Service - 43/39 GHz. Space Station affords the opportunity to place various laboratory developed receivers, transmitters, antennas, feeds, and associated components in space to conduct propagation and performance (S/N, EIRP, G/T) tests.

The Space Station will provide the platform to house the different antennas and associated RF equipments and conduct the propagation tests. The astronauts will be required to connect power lines to the equipments, assure that the antenna is properly stabilized and observe instruments that indicate that a proper RF signal is being transmitted. Installation of a new feed system may also be required.

Section 2.3

Discipline Materials Processing

GDCD ID NO.	PAYLOAD ELEMENT NAME
1200	Pilot - Biological Processing Facility
1201	Pilot - Containerless Processing Facility
1202	Pilot - Furnace Processing Facility
1203	Commercial - Biological Processing Facility
1204	Commercial - Containerless Processing Facility
1205	Commercial - Furnace Processing Facility
1206	Electrophoresis Free-Flyer
1207	Electrophoretic Separation
1208	Crystal Growth
1209	Metal Clusters and Crystal Growth
1210	Enzyme Production and Separation
1211	Silicon Crystals
1212	Heat Resistant Alloys
1213	Chemical Reactions
1214	Space Isothermal Furnace System (SIFS)

PAYLOAD ELEMENT NAME
Pilot - Bio Proc Facility

CODE
G D C D 1 2 0 0

TYPE
- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A): 8

CONTACT
Name / Address: W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone: (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr: 1992
No. of flights: 1
Duration of Flight, days: 730

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10: 10

OBJECTIVE

Provide a moderate scale biological processing facility for process development and optimization, and initial commercial output.

DESCRIPTION

This facility contains processing and support equipment for development of processes such as continuous flow and stationary column electrophoresis and isoelectric focusing, for the purification and separation of biologicals such as cells, proteins and hormones.

CODE G D C D 1 2 0 0

ORBIT CHARACTERISTICS

Apogee, km >400 Perigee, km >400 Tolerance + ______ - ______
Inclination, deg Any Tolerance + ______ - ______
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec ______ Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☒ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	8000	2
Standby	150	
Peak	10,000	22

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☒ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☒ Digital ☒ Hrs/Day 24
Film (Amount) ______ Voice (Hrs/Day) .5
Live TV (Hrs/Day) 0 Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 3 Downlink Frequency (MHZ) ______

CODE
G D C D 1 2 0 0

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min 8000 max 10,000

non-operational min 150 max 150

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☒ Internal ☐ External ☐ Remote

Equipment ID/Function ☒ Pressurized ☐ Unpressurized

L,m 2.87 W,m .75 H,m 2. Stowed

L,m 2.87 W,m .75 H,m 2. Deployed

Launch mass, kg 1050

Consumables Types Cells, Proteins, Fluids, LN_2

Acceleration sensitivity, g min 10^{-3} max ______

CREW REQUIREMENTS

Crew Size 1

Skills (See Table B) Task Assignment ______

SKILL	2	2				
LEVEL	2	3				
Hrs/Day	2	2				

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Vacuum vents are required.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1200 ELEMENT NAME PILOT PRODUCTION - BIOLOGICAL PROCESSING FACILITY

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1992 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   4 HRS PER DAY (INTERNAL) 26 days per month.

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) 1994 INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. Station operations.
3. Crew activity description: Monitor, control/manipulate, measure/record, load/unload samples, preserve and store samples, clean out equipment. Repair equipment as necessary
   Some equipment operates 24 hours per day

TOTAL EVA HRS 0

Code: GDCD 1200

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Pilot Production - Biological Processing Facility

Reference Documents:

1. TRW Report MPS .6-80-286, Vol. II, "MEC Payloads Handbook", 30 January 1981

Narrative:

This is a pilot production facility for biological processing process development and optimization, and for initial commercial output.

The facility contains processing and support modules as shown below:

Processing Module	Support Module	Pwr, kw
CFE (10 Columns) SEC (5 Columns) IEF (10 Columns)	1	2-8/10

Multiple columns can be run in parallel, but all columns cannot be run simultaneously.

Equipment physical characteristics were derived from Ref 1, Section 11. They are summarized in Table 1200-1.

Launch date and mission duration were derived.

1. Descriptive data for all attached payload elements is based upon MPS .6-80-286, Vol. II, MEC Payloads Handbook (TRW). All mass and volume values include a 25% growth factor.

2. Power levels shown are for the largest specimen sizes.

3. Abbreviations used are as follows:

AC	Acoustic Containerless
ASES	Advanced Solidification Experiment System
BIO	Biological
CFE	Continuous Flow Electrophoresis
EMC	Electromagnetic Containerless
ESC	Electrostatic Containerless
FZ	Floating Zone
F/C	Fluids/Chemistry
HGDS	High Gradient Directional Solidification
IEF	Isoelectric Focusing
SCG	Solution Crystal Growth
SEC	Stationary Electrophoresis Column
VCG	Vapor Crystal Growth

4. The source data expresses equipment sinze in terms of volume rather than dimensions. In a manned laboratory the equipment would be packaged in equipment racks, or with dimensions similar to racks. Therefore, to derive the L by W by H dimensions required for the Payload Element Data Sheets, rack cross-sections of 2m high by 0.75m deep were assumed. The rack length was then calculated by: $L = \frac{V}{1.5}$ m

Code: GDCD 1200

PAYLOAD ELEMENT SYNTHESIS

TABLE 1200-1
EQUIPMENT PHYSICAL CHARACTERISTICS

PROCESS (QTY)		PROCESSING MODULE		SUPPORT MODULE		TOTALS	
		MASS kg	VOLUME m^3	MASS kg	VOLUME m^3	MASS kg	VOLUME m^3
BIO:	(25)	670	2.1	380	2.2	1,050	4.3
CFE	(10)						
SEC	(10)						
IEF	(10)						

PAYLOAD ELEMENT NAME
Pilot - Containerless Proc Facil

CODE G D C D 1 2 0 1

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1994
No. of flights 1
Duration of Flight, days 1095

TYPE

- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 8

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

OBJECTIVE

Provide a moderate scale containerless processing facility for process development and optimization, and initial commercial output.

DESCRIPTION

This facility contains processing and support equipment for the development of processing such as acoustic, electromagnetic and electrostatic containerless processing for the production of ultrapure glasses, alloys, ceramics and crystals.

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CODE
GDCD1201

ORBIT CHARACTERISTICS

Apogee, km >400 Perigee, km >400 Tolerance + ____ -
Inclination, deg Any Tolerance + ____ -
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☒ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	12,000	4
Standby		
Peak	25,000	4

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☒ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☒ Digital ☒ Hrs/Day 8
Film (Amount) ____ Voice (Hrs/Day) 2
Live TV (Hrs/Day) 2 Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 3 Downlink Frequency (MHZ) ____

CODE G D C D 1 2 0 1

THERMAL

☒ Active ☐ Passive

Temperature, deg C operational min ____ max ____
non-operational min ____ max ____

Heat Rejection, w operational min 1000 max 25,000
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☒ Internal ☐ External ☐ Remote

Equipment ID/Function ☒ Pressurized ☐ Unpressurized

L,m 8.6 W,m .75 H,m 2 Stowed
L,m 8.6 W,m .75 H,m 2 Deployed

Launch mass, kg 3900

Consumables Types Raw Materials, Gases

Acceleration sensitivity, g min 10^{-3} max ____

CREW REQUIREMENTS

Crew Size 1

Task Assignment ____

Skills (See Table B)

SKILL	5	5				
LEVEL	2	3				
Hrs/Day	4	4				

EVA ☐ YES ☒ NO Reason ____ Hrs/EVA ____

SERVICING/MAINTENANCE

SERVICE: Interval, days ____ Consumables, kg ____
Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Vacuum vents are required.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1201 ELEMENT NAME PILOT PRODUCTION - CONTAINERLESS PROCESSING

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1994 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   8 HRS PER DAY (INTERNAL) 26 days per month (crew and equipment)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) 1997 INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. Station operations.
3. Crew activity description: Monitoring, Control/mainpulate, measure/record, load/unload samples, clean out equipment, package samples.

TOTAL EVA HRS 0

Code: GDCD 1201

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Pilot Production - Containerless Processing Facility

Reference Documents:

1. TRW Report MPS .6-80-286, Vol. II, "MEC Payloads Handbook", 30 January 1981

Narrative:

This is a pilot production facility for containerless processing process development and optimization, and the initial commercial output.

The facility contains processing and support modules as shown below:

Processing Module	Support Module	Pwr, kw
AC (2) EMC (1) ESC (2)	1	2.5-12/25

The furnaces share the support module and either two AC or ESC furnaces or the EMC furnace can be supported simultaneously.

Equipment physical characteristics were derived from Ref 1, Sections 6, 7, and 8. They are summarized in Table 1201-1.

Launch date and mission duration were derived.

TABLE 1201-1
EQUIPMENT PHYSICAL CHARACTERISTICS

PROCESS	(QTY)	PROCESSING MODULE MASS kg	PROCESSING MODULE VOLUME m^3	SUPPORT MODULE MASS kg	SUPPORT MODULE VOLUME m^3	TOTALS MASS kg	TOTALS VOLUME m^3
AC	(2)	700	2.0				
EMC	(1)	1460	4.8	1040	4.1	3,900	12.9
ESC	(2)	700	2.0				

PAYLOAD ELEMENT NAME
Pilot - Furnace Proc Facility

CODE GDCD1202

TYPE
- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A): 8

CONTACT

Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1994
No. of flights 1
Duration of Flight, days 1095

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10: 10

OBJECTIVE

Provide a moderate scale furnace processing facility for process development and optimization, and initial commercial output.

DESCRIPTION

This facility contains processing and support equipment for development of processes such as isothermal and gradient solidification, floating zone, vapor and solution crystal growth for the production of semiconductors, detectors, alloys, composites and single crystals.

CODE G D C D 1 2 0 2

ORBIT CHARACTERISTICS

Apogee, km >400 Perigee, km >400 Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☒ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	30,000	12
Standby		
Peak	50,000	12

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☒ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☒ Digital ☒ Hrs/Day 24
Film (Amount) ____ Voice (Hrs/Day) 1
Live TV (Hrs/Day) 1 Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 10 Downlink Frequency (MHZ) ____

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CODE G D C D 1 2 0 2

THERMAL

[X] Active [ ] Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min 30,000 max 50,000
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: [X] Internal [ ] External [ ] Remote

Equipment ID/Function [X] Pressurized [ ] Unpressurized

L,m 8.03 W,m .75 H,m 2. Stowed
L,m 8.03 W,m .75 H,m 2. Deployed

Launch mass, kg 4,452

Consumables Types Raw Materials, Gases

Acceleration sensitivity, g min 10^{-5} max ______

CREW REQUIREMENTS

Crew Size 1 Task Assignment ______

Skills (See Table B)

SKILL	5	5				
LEVEL	2	3				
Hrs/Day	2	2				

EVA [ ] YES [X] NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Vacuum vents are required.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1202 ELEMENT NAME PILOT PRODUCTION - FURNACE PROCESSING

ACCOMODATION: [X] ATTACHED [ ] FREE FLYER [ ] OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1994 INT. HRS ____ EVA HRS ____ EVA CREW ____

[ ] NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

[ ] TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

[X] NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

4 HRS PER DAY (INTERNAL) 26 days per month

____ HRS PER DAY (EVA)

[ ] NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

[ ] TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

[X] NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) 1997 INT. HRS. ____ EVA HRS ____ EVA CREW ____

[ ] NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. Station operations.
3. Crew activity description: Monitoring, control/manipulate, measure/record, load/unload samples, clean out equipment, package samples. Repair equipment as required.
Some equipment operates 24 hours per day.

TOTAL EVA HRS 0

Code: GDCD 1202

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Pilot Production - Furnace Processing Facility

Reference Documents:

1. TRW Report .6-80-286, Vol. II, "MEC Payloads Handbook", 30 January 1981

Narrative:

This is a pilot production facility for several types of furnace processing process development and optimization, and for initial commercial output.

The facility contains processing and support modules as shown below:

Processing Module		Support Module	Pwr, kw	
ASES	(2)	1	2.5-12/25	30/50
HGDS	(2)			
FZ	(1)			
VCG	(5)	1	2.5-30	
SCG	(12)			

Various combinations of furnaces can be run simultaneously, depending upon specimen sizes, but all furnaces cannot be run simultaneously.

Equipment physical characteristics were derived from Ref 1, Sections 3, 4, 5, 9, and 10. They are summarized in Table 1202-1.

Launch date and mission duration were derived.

1. Description data for all attached payload elements is based upon MPS .6-80-286, Vol. II, MEC Payloads Handbook (TRW). All mass and volume values include a 25% growth factor.

2. Power levels shown are for the largest specimen sizes.

3. Abbreviations used are as follows:

AC	Acoustic Containers
ASES	Advanced Solidification Experiment System
BIO	Biological
CFE	Continuous Flow Electrophoresis
EMC	Electromagnetic Containerless
ESC	Electrostatic Containerless
FZ	Floating Zone
F/C	Fluids/Chemistry
HGDS	High Gradient Directional Solidification
IEF	Isolectric Focusing
SCG	Solution Crystal Growth
SEC	Stationary Electrophoresis Column
VCG	Vapor Crystal Growth

4. The source data expresses equipment size in terms of volume rather than dimensions. In a manned laboratory the equipment would be packaged in equipment racks, or with dimensions similar to racks. Therefore, to derive the L by W by H dimensions required for the Payload Element Data Sheets, rack cross-sections of 2m high by 0.75m deep were assumed. The rack length was then calculated by: $L = \frac{V}{1.5}$ m

Code: GDCD 1202 PAYLOAD ELEMENT SYNTHESIS

TABLE 1202-1
EQUIPMENT PHYSICAL CHARACTERISTICS

PROCESS	(QTY)	PROCESSING MODULE MASS kg	PROCESSING MODULE VOLUME m^3	SUPPORT MODULE MASS kg	SUPPORT MODULE VOLUME m^3	TOTALS MASS kg	TOTALS VOLUME m^3
ASES	(2)	1082	1.0				
HGDS	(2)	1125	2.75	875	3.8	3,392	8.55
FZ	(1)	310	1.0				
VDG	(5)	410	1.2				
SCG	(12)	288	1.0	362	1.3	1060	3.5
				TOTAL		4452 kg	12.05 m^3

PAYLOAD ELEMENT NAME
Commercial - Biol Proc Facility

CODE G D C D 1 2 0 3

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1995
No. of flights 1
Duration of Flight, days 1825

OBJECTIVE

Provide full scale biological processing facility for commercial production of pharmaceuticals.

TYPE
- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 8

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10.

DESCRIPTION

This facility contains processing and support equipment utilizing processes such as continuous flow and stationary column electrophoresis and isoelectric focusing, for the purification and separation of biologicals such as cells, proteins and hormones.

CODE GDCD1203

ORBIT CHARACTERISTICS

Apogee, km >400 Perigee, km >400 Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☒ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	16,000	4
Standby	300	
Peak	20,000	20

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☒ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☒ Digital ☒ Hrs/Day 24
Film (Amount) ____ Voice (Hrs/Day) 1
Live TV (Hrs/Day) 0 Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 6 Downlink Frequency (MHZ) ____

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CODE G D C D 1 2 0 3

THERMAL

☒ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min 16,000 max 20,000

non-operational min 300 max 300

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☒ Internal ☐ External ☐ Remote

Equipment ID/Function ☒ Pressurized ☐ Unpressurized

L,m 5.73 W,m .75 H,m 2. Stowed

L,m 5.73 W,m .75 H,m 2. Deployed

Launch mass, kg 2100

Consumables Types Cells, Proteins, Fluids, LN_2

Acceleration sensitivity, g min 10^{-3} max ______

CREW REQUIREMENTS

Crew Size 1

Task Assignment ______

Skills (See Table B)

SKILL	2	2				
LEVEL	2	3				
Hrs/Day	4	4				

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Vacuum vents are required.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1203 ELEMENT NAME COMMERCIAL BIOLOGICALS PROCESSING

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1995 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   8 HRS PER DAY (INTERNAL) 26 days per month

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Station Operations
3. Crew activity description: Monitor equipment operation, load/unload products, clean out equipment, perform quality control checks, preserve and store products. Repair equipment as required. Equipment operates 24 hours per day.
5. Continues after year 2000

TOTAL EVA HRS 0

Code: GDCD 1203

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Commercial Production - Biological Processing Facility

Reference Documents:

1. TRW Report MPS .6-80-286, Vol. II, "MEC Payloads Handbook", 30 January 1981

Narrative:

This is a commercial production facility for biological products.

The facility contains processing and support modules as shown below:

Processing Module	Support Module	Pwr, kw
CFE (20 Columns) SEC (10 Columns) IEF (20 Columns)	1	4-16/20

Multiple columns can be run in parallel, but all columns cannot be run simultaneously.

Equipment physical characteristics were derived from Ref 1, Section 11. They are summarized in Table 1203-1.

Launch date and mission duration were derived.

TABLE 1203
EQUIPMENT PHYSICAL CHARACTERISTICS

PROCESS (QTY)		PROCESSING MODULE		SUPPORT MODULE		TOTALS	
		MASS kg	VOLUME m^3	MASS kg	VOLUME m^3	MASS kg	VOLUME m^3
BIO:	(50)	1340	4.2	760	4.4	2,100	8.6
CFE	(20)						
SEC	(10)						
IEF	(20)						

PAYLOAD ELEMENT NAME
Comml-Containerless Proc Facil

CODE G D C D 1 2 0 4

TYPE
- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 8

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1997
No. of flights 1
Duration of Flight, days 1095+

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

OBJECTIVE

Provide full scale containerless processing facility for commercial production of high value materials with superior properties.

DESCRIPTION

This facility contains processing and support equipment that utilize acoustic, electromagnetic and electrostatic containerless processing for the production of ultrapure glasses, alloys, ceramics and crystals.

CODE G D C D 1 2 0 4

ORBIT CHARACTERISTICS

Apogee, km >400 Perigee, km >400 Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stabil: y (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☒ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	26,000	20
Standby		
Peak	38,000	4

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☒ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☒ Digital ☒ Hrs/Day 24
Film (Amount) ____ Voice (Hrs/Day) 2
Live TV (Hrs/Day) 1 Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 6 Downlink Frequency (MHZ) ____

CODE G D C D 1 2 0 4

THERMAL

☒ Active ☐ Passive

Temperature, deg C operational min ____ max ____
non-operational min ____ max ____

Heat Rejection, w operational min 26,000 max 38,000
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☒ Internal ☐ External ☐ Remote

Equipment ID/Function ☒ Pressurized ☐ Unpressurized

L,m 13.53 W,m .75 H,m 2 Stowed
L,m 13.53 W,m .75 H,m 2 Deployed

Launch mass, kg 5700

Consumables Types Raw Materials, Gases

Acceleration sensitivity, g min 10^{-3} max ____

CREW REQUIREMENTS

Crew Size 1 Task Assignment ____

Skills (See Table B)

SKILL	5	5				
LEVEL	2	3				
Hrs/Day	4	4				

EVA ☐ YES ☒ NO Reason ____ Hrs/EVA ____

SERVICING/MAINTENANCE

SERVICE: Interval, days ____ Consumables, kg ____
Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Vacuum vents are required.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1204 ELEMENT NAME COMMERCIAL CONTAINERLESS PROCESSING

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1997 INT. HRS ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ______ DAYS TOTAL SERVICES ______

   ☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

   ☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

   EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   8 HRS PER DAY (INTERNAL) 26 days per month

   ______ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ______ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Station operations.
3. Crew activity description: Monitor equipment operation, load/unload products, clean out equipment, perform quality control checks, package products. Repair equipment as required.
   Some equipment operates 24 hours per day.
5. Continues after year 2000.

TOTAL EVA HRS 0

Code: GDCD 1204

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Commercial Production - Containerless Processing Facility

Reference Documents:

1. TRW Report MPS .6-80-286, Vol. II, "MEC Payloads Handbook", 30 January 1981

Narrative:

This is a commercial production facility using containerless processing.

The facility contains processing and support modules as shown below:

Processing Module	Support Module	Pwr, kw	
AC (3)	1	26	26/38
EMC (1)	1	12	
ESC (3)	1	26	

Each type of processing module can be run simultaneously. Chambers can be run simultaneously for small specimens, and singly for large specimens.

Equipment physical characteristics were derived from Ref 1, Section 6, 7, and 8. They are summarized in Table 1204-1.

Launch date and mission duration were derived.

Code: GDCD 1204

PAYLOAD ELEMENT SYNTHESIS

1. Description data for all attached payload elements is based upon MPS .6-80-286, Vol. II, MEC Payloads Handbook (TRW). All mass and volume values include a 25% growth factor.

2. Power levels shown are for the largest specimen sizes.

3. Abbreviations used are as follows:

AC	Acoustic Containers
ASES	Advanced Solidification Experiment System
BIO	Biological
CFE	Continuous Flow Electrophoresis
EMC	Electromagnetic Containerless
ESC	Electrostatic Containerless
FZ	Floating Zone
F/C	Fluids/Chemistry
HGDS	High Gradient Directional Solidification
IEF	Isolectric Focusing
SCG	Solution Crystal Growth
SEC	Stationary Electrophoresis Column
VCG	Vapor Crystal Growth

4. The source data expresses equipment size in terms of volume rather than dimensions. In a manned laboratory the equipment would be packaged in equipment racks, or with dimensions similar to racks. Therefore, to derive the L by W by H dimensions required for the Payload Element Data Sheets, rack cross-sections of 2m high by 0.75m deep were assumed. The rack length was then calculated by: $L = \frac{V}{1.5}$ m

TABLE 1204-1
EQUIPMENT PHYSICAL CHARACTERISTICS

PROCESS (QTY)		PROCESSING MODULE		SUPPORT MODULE		TOTALS	
		MASS kg	VOLUME m^3	MASS kg	VOLUME m^3	MASS kg	VOLUME m^3
AC	(3)	1100	3.4	500	2.3	1,600	5.7
EMC	(1)	1460	4.8	1040	4.1	2,500	8.9
ESC	(3)	1100	3.4	500	2.3	1,600	5.7
				TOTAL		5,700 kg	20.3 m^3

PAYLOAD ELEMENT NAME
Comm-Furnace Proc Facility

CODE G D C D 1 2 0 5

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 1997
No. of flights 1
Duration of Flight, days 1460+

TYPE
☐ Science & Applications (non-commercial)
☒ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 8

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 10

OBJECTIVE

Provide full scale furnace processing facility for commercial production of high value materials with superior properties.

DESCRIPTION

This facility contains processing and support equipment that utilize isothermal and gradient solidification, floating zone, vapor and solution crystal growth processes, for the production of semiconductors, detectors, alloys, composites and single crystals.

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CODE G D C D 1 2 0 5 Page 2 of 3

ORBIT CHARACTERISTICS

Apogee, km >400 Perigee, km >400 Tolerance + ____ -
Inclination, deg Any Tolerance + ____ -
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☒ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	40,000	20
Standby		
Peak	70,000	4

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☒ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☒ Digital ☒ Hrs/Day 24
Film (Amount) ____ Voice (Hrs/Day) 2
Live TV (Hrs/Day) 1 Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 10 Downlink Frequency (MHZ) ____

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CODE G D C D 1 2 0 5

THERMAL

☒ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min 40,000 max 70,000
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 15 W,m .75 H,m 2 Stowed
L,m 15 W,m .75 H,m 2 Deployed

Launch mass, kg 6325

Consumables Types Raw Materials, Gases

Acceleration sensitivity, g min 10-5 max ______

CREW REQUIREMENTS

Crew Size 1 Task Assignment ______

Skills (See Table B)

SKILL	5	5				
LEVEL	2	3				
Hrs/Day	4	4				

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Vacuum vents are required.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GOCD CODE 1205 ELEMENT NAME COMMERCIAL FURNACE PROCESSING

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1997 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   8 HRS PER DAY (INTERNAL) 26 days per month

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Station operations.
3. Crew activity description: Monitor equipment operation, load/unload products, clean out equipment, perform quality control checks, package products. Repair equipment as required.
   Some equipment operates 24 hours per day.
5. Continues after year 2000

TOTAL EVA HRS 0

Code: GDCD 1205

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Commercial Production - Furnace Processing Facility

Reference Documents:

1. TRW Report MPS .6-80-286, Vol. II, "MEC Payloads Handbook", 30 January 1981

Narrative:

This is a commercial production facility using several types of furnace processing.

The facility contains processing and support modules as shown below:

Processing Module		Support Module	Pwr, kw	
ASES	(4)	1	2-24	40/70
HGDS	(4)	1	2.5-40	
FZ	(2)	1	4-40	
VCG	(5)	1	2.5-30	
SCG	(12)	1	1.5-14	

Each type of processing module can be run simultaneously. Furnaces can be run simultaneously for small specimens, and in various combinations for large specimens.

Equipment physical characteristics were derived from Ref 1, Section 3, 4, 5, 9, and 10. They are summarized in Table 1205-1.

Launch date and mission duration were derived.

1. Description data for all attached payload elements is based upon MPS .6-80-286, Vol. II, MEC Payloads Handbook (TRW). All mass and volume values include a 25% growth factor.

2. Power levels shown are for the largest specimen sizes.

3. Abbreviations used are as follows:

AC	Acoustic Containers
ASES	Advanced Solidification Experiment System
BIO	Biological
CFE	Continuous Flow Electrophoresis
EMC	Electromagnetic Containerless
ESC	Electrostatic Containerless
FZ	Floating Zone
F/C	Fluids/Chemistry
HGDS	High Gradient Directional Solidification
IEF	Isolectric Focusing
SCG	Solution Crystal Growth
SEC	Stationary Electrophoresis Column
VCG	Vapor Crystal Growth

4. The source data expresses equipment size in terms of volume rather than dimensions. In a manned laboratory the equipment would be packaged in equipment racks, or with dimensions similar to racks. Therefore, to derive the L by W by H dimensions required for the Payload Element Data Sheets, rack cross-sections of 2m high by 0.75m deep were assumed. The rack length was then calculated by: $L = \frac{V}{1.5}$ m

TABLE 1205-1
EQUIPMENT PHYSICAL CHARACTERISTICS

PROCESS	(QTY)	PROCESSING MODULE MASS kg	PROCESSING MODULE VOLUME m^3	SUPPORT MODULE MASS kg	SUPPORT MODULE VOLUME m^3	TOTALS MASS kg	TOTALS VOLUME m^3
ASES	(4)	1512	2.6	238	3.8	1,750	6.4
HGDS	(4)	1425	3.65	875	3.55	2,300	7.2
FZ	(2)	535	1.7	440	2.5	975	4.2
VGC	(5)	410	1.2	240	1.3	650	2.5
SCG	(12)	288	1.0	362	1.2	650	2.2
				TOTAL		6,325 kg	22.5 m^3

PAYLOAD ELEMENT NAME
Electrophoresis Free-Flyer

CODE G D C D 1 2 0 6

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☒ Planned
- ☐ Candidate
- ☐ Opportunity

First flight, yr 1986
No. of flights 5
Duration of Flight, days 1825

TYPE

- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 8

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 6

OBJECTIVE

To begin near-term commercial manufacturing of pharmaceutical products.

DESCRIPTION

The electrophoresis operations in space (EOS) free-flyer consists of a production module, a resupply module and a support bus such as a leasecraft. Five such vehicles are planned launched one per year. Initial operations will be Shuttle supported.

ORIGINAL PAGE IS
OF POOR QUALITY

CODE G D C D 1 2 0 6

ORBIT CHARACTERISTICS

Apogee, km >400 Perigee, km >400 Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☒ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☒ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

ORIGINAL PAGE IS
OF POOR QUALITY

CODE G D C D 1 2 0 6

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☒ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 5.5 W,m 4.27 H,m 4.27 Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 9,987

Consumables Types ______

Acceleration sensitivity, g min ______ max 10^{-3}

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days 180 Consumables, kg 2,500
Returnables, kg 2,200 Man Hours 24

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

This free-flyer is typical of others that may be utilized for other types of materials processing such as crystal growth.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GOCD CODE 1206 ELEMENT NAME ELECTROPHORESIS FREE-FLYER

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1990* INT. HRS ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE *Last activation shown (1 per year starting in 1986, total of 5)

2. SERVICE (E.G., REPLENISH/RESUPPLY) for each of 5 spacecraft

INTERVAL 180 DAYS TOTAL SERVICES ______

☒ TMS/OTV ~~REQUIRED~~ ALTERNATE STATION HRS PER SERVICE 24

☐ NOT APPLICABLE EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

______ HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☒ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) 1995* INT. HRS. ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE *Last deactivation shown (1 per year starting in 1991, total of 5)

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

This payload element has orbit transfer propulsion

1. and 5. Station operations
2. Free flyers will be serviced at Space Station at 180 day intervals. Logistics modules will be exchanged using an RMS-type manipulator. The support bus will have propellant replenished and repair (if required) will be by module replacement.
No EVA is planned for servicing.
EVA may be required for contingency repair work

TOTAL EVA HRS 0

Code: GDCD 1206

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Electroporesis Free-Flyer

Reference Documents:

1. "System Requirements for Baseline Materials Processing in Space Payloads (System Requirements Document)", Document No. SP81-MSFC-2535, June 1981. Prepared by Teledyne Brown Engineering.

2. "Fairchild Leasecraft System", briefing presented on 11 Nov. 1982 at GDC (Document No. GDC 20-003).

Narrative:

This payload consists of an Electrophoresis Operations in Space (EOS) production plant coupled to a Leasecraft support bus. The production plant will consist of Factory and Resupply modules.

The EOS Resupply Module (EOS-RM) provides a means of transporting new materials (up) and product (down). The EOS Factory Module (EOS-FM) remains on orbit with the support bus for periods of 5 years with the EOS-RMs being exchanged at 6-month intervals.

The Leasecraft bus has an augmented power subsystem capable of continuously supplying 3500 watts to the EOS production plant.

Mass properties for the EOS Free-Flyer are given in Table 1206-1.

Equipment characteristics for the FOS production plant were obtained from Ref 1, Sections 4.3 and 5.3.

Leasecraft characteristics were obtained from Ref 2.

Table 1206-1. Electrophoresis Free-Flyer Mass Summary

ELEMENT	MASS lb	MASS kg
Factory Module(1)	5,000.	2,268.
Resupply Module - Up(1)	5,000.	2,268.
(Resupply Module - Down)(1)	(4,700)	(2,132)
Leasecraft Dry Weight(2)	6,000.	2,722.
Total propellants(2)	6,000.	2,722.
(Useable propellants -95%)(3)	(5,700)	(2,586)
Launch Weight - Fully Loaded	22,000.	9,979.

NOTES:
(1) Ref 1, pp 4-15
(2) Ref 2
(3) GDC estimate

Initial EOS launch in 1986 is from MDAC/Fairchild preliminary planning. Five free-flyers will be launched and supported by the shuttle between 1986 and 1990. Support can be taken over by the Space Station in 1990, or whenever convenient to phase in.

This payload will be shuttle supported during the initial operating period. For Space Station supported operaztions, the Leasecraft bus will return the payload to the station, periodically and the resupply module will be exchanged by a space station provided RMS.

PAYLOAD ELEMENT NAME
Electrophoretic Separation

CODE
G D C D 1 2 0 7

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 7

TYPE

- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 8

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

OBJECTIVE

Purification of biomaterials.

DESCRIPTION

Research leading to the development of electrophoretic purification methods complementary to those developed by McDonnell Douglas.
GDCD 0400 Research and Development facility could accommodate this payload segment.

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CODE G D C D 1 2 0 7

ORBIT CHARACTERISTICS

Apogee, km Any Perigee, km Any Tolerance + ___ - ___
Inclination, deg Any Tolerance + ___ - ___
Nodal Angle, deg ___ Ephemeris Accuracy, m ___
Escape dV Required, m/s ___

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ___
Pointing accuracy, arc sec ___ Field of view, deg ___
Pointing Stability (Jitter) arc sec/sec ___
Special Restrictions (Avoidance) ___

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	100 - 500	
Standby		
Peak		

☐ Continuous

Voltage, V ___ Frequency, Hz ___

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☒ Other Astronaut Intervention
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ___ Frequency (MHZ) ___
☐ On-Board Data Processing Required
Description
Digital Data Recorder and General Purpose Computer
Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day ___
Film (Amount) ___ Voice (Hrs/Day) ___
Live TV (Hrs/Day) ___ Other ___
On-Board Storage (MBIT) ___
Data Dump Frequency (Per Orbit) ___
Recording Rate (KBPS) ___ Downlink Frequency (MHZ) ___

ORIGINAL PAGE IS
OF POOR QUALITY

CODE G D C D 1 2 0 7

THERMAL
☐ Active ☐ Passive
Temperature, deg C operational min ______ max ______
non-operational min ______ max ______
Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS
Location: ☒ Internal ☐ External ☐ Remote
Equipment ID/Function ☒ Pressurized ☐ Unpressurized
L,m 1.0 - 1.4 W,m 1.0 - 1.4 H,m 1.0 - 1.4 Stowed
L,m ______ W,m ______ H,m ______ Deployed
Launch mass, kg 100 - 300
Consumables Types ______
Acceleration sensitivity, g min ______ max 10^{-4}

CREW REQUIREMENTS
Crew Size 1
Skills (See Table B)

Task Assignment		Control	Preprogrammed	Exp.	Ops.	
SKILL	5					
LEVEL	2					
Hrs/Day	<0.5					

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE
SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______
CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

1) Can tolerate up to 10^{-2}g transient acceleration. 2) May emit gaseous contamination. 3) Requires refrigerator, freezer, tissue culture facilities storage. 4) Can involve living cells in tissue culture.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1207 ELEMENT NAME ELECTROPHORETIC SEPARATION

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1990 INT. HRS ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ______ DAYS TOTAL SERVICES ______

   ☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

   ☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

   EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.5 HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ______ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. Accommodated in - 0400 facility
3. Seven day mission crew tasks: Monitor, control/manipulate, measure/record, load/unload samples, preserve and store samples. Crew tasks are not additive to -0400 crew tasks

TOTAL EVA HRS 0

Code: GDCD 1207

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Electrophonetic Separation .

Reference Documents:

1. University of Arizona, Biophysics Technology Laboratory, User Fact Sheet

Narrative:

The data was primarily from Ref 1. The objective is the purification of biomaterials using electrophonetic purification methods complimentary to those developed by MDAC. Association of this payload element with accommodating payload (GDCD 0400) was developed through visit to General Dynamics.

Mission date, crew level/skill, and crew time were derived.

PAYLOAD ELEMENT NAME
Space Mfg of Electronic Mtls

CODE G D C D 1 2 0 8

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1992
No. of flights 1
Duration of Flight, days 6.5

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 8

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

OBJECTIVE

To produce very high quality gallium arsenide and other electronic crystals in space to meet market requirements.

DESCRIPTION

GDCD 0400 Research and Development facility could accommodate this payload element. Source data for a Shuttle based payload is SP81-MSFC-2517 accommodations assessment or on-orbit, commercial growth of single crystals, March 1981.

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CODE G D C D 1 2 0 8 | Page 2 of 3

ORBIT CHARACTERISTICS

Apogee, km Any ____ Perigee, km Any ____ Tolerance + ____ - ____
Inclination, deg Any ____ Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day	
Operating	____	____	
Standby	____	____	☐ Continuous
Peak	____	____	

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

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CODE G D C D 1 2 0 8

THERMAL
☒ Active ☐ Passive
Temperature, deg C operational min ______ max ______
non-operational min ______ max ______
Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS
Location: ☐ Internal ☐ External ☐ Remote
Equipment ID/Function ☐ Pressurized ☐ Unpressurized
L,m ______ W,m ______ H,m ______ Stowed
L,m ______ W,m ______ H,m ______ Deployed
Launch mass, kg ______
Consumables Types ______
Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS
Crew Size ______ Task Assignment ______
Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☐ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE
SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______
CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Orbits of maximum sunlight desired for high energy demand furnaces to be utilized.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1208 ELEMENT NAME CRYSTAL GROWTH

ACCOMODATION: [X] ATTACHED [ ] FREE FLYER [ ] OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1992 INT. HRS ____ EVA HRS ____ EVA CREW ____

   [ ] NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   [ ] TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   [X] NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ____ HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   [X] NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   [ ] TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   [X] NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) 1992 INT. HRS. ____ EVA HRS ____ EVA CREW ____

   [ ] NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. are accommodated in -0400 facility
3. Operations of this 6.5 day mission are accounted for in -0400

TOTAL EVA HRS 0

Code: GDCD 1208

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Crystal Growth

Reference Documents:

1. Micro Graving Research Associates, User Fact Sheet

Narrative:

The data was primarily from Ref 1. The mission objective is to produce very high quality gallium arsenide and other electronic crystals in space. MRA currently has a JEA in final stages of coordination at NASA headquarters.

The relationship of this payload element with accommodating payload (GDCD 1202), was derived from association of payload objectives and requirements.

Mission date, crew level/skill, and crew time were derived.

PAYLOAD ELEMENT NAME
Metal Clusters and Crystal Growth

CODE G D C D 1 2 0 9

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 15

TYPE

☐ Science & Applications (non-commercial)
☒ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 8

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

OBJECTIVE

Use space to carry out reaction in a convection-free environment.

DESCRIPTION

Perform metal cluster chemistry and growth of organic and inorganic crystals in space. GDCD 0400 research and development facility could accommodate this payload element.

CODE GDCD1209

ORBIT CHARACTERISTICS

Apogee, km Any ______ Perigee, km Any ______ Tolerance + ______ - ______

Inclination, deg Any ______ Tolerance + ______ - ______

Nodal Angle, deg ______ Ephemeris Accuracy, m ______

Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ______

Pointing accuracy, arc sec ______ Field of view, deg ______

Pointing Stability (Jitter) arc sec/sec ______

Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	500 - 1000	
Standby		
Peak		

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☐ Realtime ☐ Offline ☐ Other ______

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______

☐ On-Board Data Processing Required

Description

Display/keyboard and general purpose computer.

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______

Film (Amount) ______ Voice (Hrs/Day) ______

Live TV (Hrs/Day) ______ Other ______

On-Board Storage (MBIT) ______

Data Dump Frequency (Per Orbit) ______

Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

CODE G D C D 1 2 0 9

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☒ Internal ☐ External ☐ Remote

Equipment ID/Function ☒ Pressurized ☐ Unpressurized

L,m 0.5 W,m 0.5 H,m <2.0 Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 30 - 100

Consumables Types ______

Acceleration sensitivity, g min ______ max 10^{-4}

CREW REQUIREMENTS

Crew Size 1

Skills (See Table B)

Task Assignment: Preprogrammed & Realtime Exp Control

SKILL	5					
LEVEL	2					
Hrs/Day	1.0					

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

1) Sensitive to particulate and gaseous contaminations and may be sensitive to RF/magnetic fields. 2) Storage for crystals and chemical samples is provided. 3) Resupply/return to Earth of materials/samples. 4) Can involve up to 10^{-2}g transient acceleration.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GOCD CODE 1209 ELEMENT NAME METAL CLUSTER & CRYSTAL GROWTH

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1990 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

1 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) 1990 INT. HRS. ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. are accommodated in -0400 facility.
3. This is a 15 day mission. Crew tasks are: monitoring, control/manipulation, measurement/record, load/unload samples, clean out equipment, unpack and package samples for earth return. Crew tasks are not additive to -0400 crew tasks.

TOTAL EVA HRS 0

Code: GDCD 1209

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Metal Crystals and Crystal Growth

Reference Documents:

1. 3M Company, User Fact Sheet

Narrative:

The data was from REf 1. The mission objective is to perform metal cluster chemistry and grow organic and inorganic crystals in a convection-free environment.

The relationships of this payload element with accommodating payload (GDCD 0400) was derived based on association of objectives and requirements.

Mission date, crew level/skill, and crew time were derived.

PAYLOAD ELEMENT NAME
Enzymes

CODE G D C D 1 2 1 0

CONTACT
Name / Address: W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days <4

OBJECTIVE

Enzyme production and/or separation.

TYPE

- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 8

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8.

DESCRIPTION

User identifies payload element description as proprietary.
GDCD 0400 research and development facility could accommodate this payload element.

CODE G D C D 1 2 1 0

ORBIT CHARACTERISTICS

Apogee, km Any Perigee, km Any Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required.m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy,arc sec ____ Field of view, deg ____
Pointing Stability (Jitter)arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage,V ____ Frequency,Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description
Digital and analog tape recorders

Data Types: ☒ Analog ☒ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C 0 1 2 1 0

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg ______

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1

Skills (See Table B)

Task Assignment		Real Time Active Control				
SKILL	5					
LEVEL	2					
Hrs/Day	2.0					

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

1) May need airlock and view port. 2) May be sensitive to gaseous and particulate contamination, radioactivity and RF/Magnetic fields. 3) Logistic resupply and sample/product return to Earth. 4) Refrigeration required for sample's products. 5) Living micro-organisms are used.

GOCD CODE 1210 ELEMENT NAME ENZYME PRODUCTION AND SEPARATION

ACCOMODATION: [X] ATTACHED [ ] FREE FLYER [ ] OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1990 INT. HRS ____ EVA HRS ____ EVA CREW ____

[ ] NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

[ ] TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

[X] NOT APPLICABLE EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

2 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

[ ] NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

[ ] TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

[X] NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) 1990 INT. HRS. ____ EVA HRS ____ EVA CREW ____

[ ] NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. are accommodated in -0400 facility
3. This is a 4 day mission. Crew tasks are: monitoring, measurement/recording, load/unload samples, preserve and store samples. unpack and package samples for earth return. Crew tasks are not additive to -0400.

TOTAL EVA HRS 0

Code: GDCD 1210

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Enzyme Production and Separation

Reference Documents:

1. A.E. Staley Mfg. Co., User Fact Sheet

Narrative:

The data was primarily from Ref 1. The mission involves fermentation of microorganism producing a useful enzyme and/or separation of enzyme constituents from broth. The association of this payload element with accommodating payload (GDCD 0400) was derived based on association of payload objectives and requirements.

Mission date, crew level/skill, and crew time were derived.

PAYLOAD ELEMENT NAME
Dislocation-Free Silicon Crystal

CODE G D C D 1 2 1 1

CONTACT

Name / Address: W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 30

TYPE

- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 8

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

OBJECTIVE

To produce dislocation-free silicon ingots with uniform and homogenous properties, both with respect to dopant distributions and to micro-defect incorporation.

DESCRIPTION

Payload element proposes the growth of 25 to 50 mm diameter, 30 cm length dislocation-free silicon crystals in a low gravity environment. The growth method is to be floating zone possibly in a mirror furnace. One crystal could be grown in about 8 hours. Additional runs would require disassembly, cleaning and setup. All reassembly of furnace in orbit. Ref. GDCD 0400 research and development facility could accommodate this payload element.

CODE G D C D 1 2 1 1

ORBIT CHARACTERISTICS

Apogee, km Any ______ Perigee, km Any ______ Tolerance + ______ -

Inclination, deg Any ______ Tolerance + ______ -

Nodal Angle, deg ______ Ephemeris Accuracy, m ______

Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ______

Pointing accuracy, arc sec ______ Field of view, deg ______

Pointing Stability (Jitter) arc sec/sec ______

Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	5000	
Standby		
Peak		

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☐ Realtime ☐ Offline ☐ Other ______

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______

☐ On-Board Data Processing Required

Description

Time-lapse photography during crystal growth - up to 8 hrs/run.

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______

Film (Amount) ______ Voice (Hrs/Day) ______

Live TV (Hrs/Day) ______ Other ______

On-Board Storage (MBIT) ______

Data Dump Frequency (Per Orbit) ______

Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

CODE G D C D 1 2 1 1

THERMAL

[X] Active [ ] Passive

Temperature, deg C operational min ______ max 1420
non-operational min ______ max ______
Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: [X] Internal [ ] External [ ] Remote
Equipment ID/Function [X] Pressurized [ ] Unpressurized
L,m 0.8 W,m 0.75 H,m 2.0 Stowed
L,m 0.8 W,m 0.75 H,m 2.0 Deployed
Launch mass, kg 100 - 300
Consumables Types ______
Acceleration sensitivity, g min ______ max 10^{-4}

CREW REQUIREMENTS

Crew Size 1
Task Assignment: Preprogrammed and Real Time Experiment Control
Skills (See Table B)

SKILL	5					
LEVEL	2					
Hrs/Day	8.0					

EVA [ ] YES [X] NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg 0.4 - 1.5 per run Man Hours ______
CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

1) Requries vent access. 2) Power/energy stated are for 25 mm diameter crystal for each run; for 50 mm diameter crystal 12,000 W power level and 100 KWh/run energy is required. 3) May be sensitive to particulate contamination, radio activity and RF/Magnetic field; 4) Can tolerate up to 10^{-2}g transient acceleration but requires vibration isolation. 6) Duration based on 30 samples, one per day.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1211 ELEMENT NAME SILICON CRYSTALS

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1990 INT. HRS ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ______ DAYS TOTAL SERVICES ______

   ☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

   ☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

   EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   8 HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ______ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) 1990 INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. are accommodated in -0400 facility
3. 20 day mission; 20 samples processed. Crew tasks: monitoring, control/manipulation, measurement/recording, load/unload samples in furnace, clean equipment, unpack and package products for earth return. Crew tasks are not additive to -0400.

TOTAL EVA HRS 0

Code: GDCD 1211

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Silicon Crystals

Reference Documents:

1. Monsanto Company, User Fact Sheet

Narrative:

The data was primarily from Ref 1. The experiment proposes to produce 25 to 50 millimeter dislocation-free silicon crystal ingots with uniform homegeneous properties both with respect to dopant distributions and to micro-defect incorporation. The growth method would be floating zone possibly in a mirror furnace.

The association with accommodating payload element (GDCD 0400) was derived from association of payload objectives and requirements.

Mission date, crew level/skill, and crew time were derived.

PAYLOAD ELEMENT NAME
Heat Resistant Alloy Processing

CODE GDCD1212

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- [ ] Operational
- [ ] Approved
- [ ] Planned
- [x] Candidate
- [ ] Opportunity

First flight, yr 1997
No. of flights 1
Duration of Flight, days 30

OBJECTIVE

User identified objective as proprietary.

TYPE
- [ ] Science & Applications (non-commercial)
- [x] Commercial
- [ ] Technology Development
- [ ] Operations

Type Number (see Table A) 8

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

DESCRIPTION

Reference GDCD 0400 research and development facility could accommodate initial experiment, and GDCD 1205 furnace processing could accommodate pilot/commercial payload element described herein, up to 70 KW level.

CODE GDCD1212

ORBIT CHARACTERISTICS

Apogee, km Any Perigee, km Any Tolerance + ___ - ___
Inclination, deg Any Tolerance + ___ - ___
Nodal Angle, deg ___ Ephemeris Accuracy, m ___
Escape dV Required, m/s ___

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ___
Pointing accuracy, arc sec ___ Field of view, deg ___
Pointing Stability (Jitter) arc sec/sec ___
Special Restrictions (Avoidance) ___

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	100,000	6
Standby		
Peak		

☐ Continuous

Voltage, V ___ Frequency, Hz ___

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ___
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ___ Frequency (MHZ) ___
☐ On-Board Data Processing Required
Description
Digital and analog tape recorder

Data Types: ☒ Analog ☒ Digital ☐ Hrs/Day ___
Film (Amount) ___ Voice (Hrs/Day) ___
Live TV (Hrs/Day) ___ Other Color Video
On-Board Storage (MBIT) ___
Data Dump Frequency (Per Orbit) ___
Recording Rate (KBPS) ___ Downlink Frequency (MHZ) ___

CODE G D C D 1 2 1 2

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ____ max ____

non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____

non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☒ Internal ☒ External ☐ Remote

Equipment ID/Function ☒ Pressurized ☒ Unpressurized

L,m ____ W,m ____ H,m ____ Stowed

L,m ____ W,m ____ H,m ____ Deployed

Launch mass, kg 5000

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 1

Task Assignment Real Time Exp Control, c/o service

Skills (See Table B)

SKILL	3					
LEVEL	5					
Hrs/Day	8					

EVA ☐ YES ☒ NO Reason ____ Hrs/EVA ____

SERVICING/MAINTENANCE

SERVICE: Interval, days ____ Consumables, kg ____

Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____

Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

1) Logistic support for raw materials and return products. 2) storage for corrosive/toxic gases and raw materials. 3) May emit particulate and gaseous contamination and provides RF/magnetic fields; sensitive to gaseous contamination and RF/magnetic fields. 4) Power level shown for pilot/commercial operations after 10 years experimentation; initial power could be 2500 to 5000W 5) Weight shown for pilot operations; initial weight could be 100 Kg. 6) Duration based on 30 samples, one per day.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1212 ELEMENT NAME HEAT RESISTANT ALLOYS

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1997 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   8 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) 1997 INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. are accommodated in -1205 facility
3. This is a 30 day mission; 30 samples will be processed. Crew tasks: Monitoring, repair/replacement, load/unload products, clean out equipment, perform quality control checks. Crew tasks are not additive to -0400

TOTAL EVA HRS 0

Code: GDCD 1212

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Heat Resistant Alloy Processing

Reference Documents:

1. INCO Alloy Products User Fact Sheet

Narrative:

Objective to explore ways of using zero gravity to improve thermal and corrosion resistance properties of alloys, orbit, mass, power, data, crew size and hours and special considerations provided by Ref 1. Stated maximum power level was greater than other estimates. Although it was retained in payload excellent definition, it is believed to be high and was not used in station sizing. If such high powers do become required, the modular architectural will make it possible to satisfy user requirements. Timing, accommodaticn by GDCD 0400 and 1205 and other data were derived.

PAYLOAD ELEMENT NAME
Chemical Reactions

CODE
G D C D 1 2 1 3

CONTACT

Name
Address

W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 7

TYPE

- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 8

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

OBJECTIVE

Determine influence of microgravity on chemical reactions.

DESCRIPTION

GDCD 0400 research and development facility could accommodate this payload element.

CODE G D C D 1 2 1 3

ORBIT CHARACTERISTICS

Apogee, km Any Perigee, km Any Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	____	____
Standby	____	____
Peak	____	____

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 1 2 1 3

THERMAL
☐ Active ☐ Passive
Temperature, deg C operational min ______ max ______
non-operational min ______ max ______
Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS
Location: ☐ Internal ☐ External ☐ Remote
Equipment ID/Function ☐ Pressurized ☐ Unpressurized
L,m ______ W,m ______ H,m ______ Stowed
L,m ______ W,m ______ H,m ______ Deployed
Launch mass, kg ______
Consumables Types ______
Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS
Crew Size 1 Task Assignment Experiment ON/OFF
Skills (See Table B)

SKILL	1					
LEVEL	2					
Hrs/Day	0.5					

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE
SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______
CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions
Return of samples/products required.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCO CODE 1213 ELEMENT NAME CHEMICAL REACTIONS

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1990 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.5 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) 1990 INT. HRS. ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. are accommodated in -0400 facility
3. This is a 7 day mission. Crew tasks are: monitor, control, manipulate, measure, record, load/unload samples, clean out equipment, package samples for return to earth. Crew tasks are not additive to -0400.

TOTAL EVA HRS 0

Code: GDCD 1213

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Chemical Reactions

Reference Documents:

1. E. I. DuPont de Nemours User Fact Sheet

Narrative:

Objective to determine influence, if any, of microgravity on chemical relations, orbit, crew involvement, and compatibility considerations provided in Ref 1. All other data including accommodation by GDCD 0400 were derived.

PAYLOAD ELEMENT NAME
Space Isothermal Furnace (SIFS)

CODE G D C D 1 2 1 4

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☒ Planned
- ☐ Candidate
- ☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 4

TYPE

- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 8

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

OBJECTIVE

Provide materials processing facility for commercial materials processing in space under micro gravity conditions.

DESCRIPTION

The space isothermal furnace system (SIFS) consists of multi-furnace modules, each capable of isothermal processing solid materials from 500°C to 1500°C. The system can process 220 samples within 80 hours and 60 - 70 KW of energy. A variety of materials with different heating rates, control isothermal process time and temperatures, and cooling rates to stable resolidification are possible.
GDCD 0400 research and development facility could accommodate this payload element.

CODE
G D C 0 1 2 3 4

ORBIT CHARACTERISTICS

Apogee, km >250 Perigee, km >250 Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	700	
Standby		
Peak	2000	

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description
Voice; CAUTION and WARNING; Acceleration level time-tag, accelerometer

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 1 2 1 4

THERMAL
☐ Active ☐ Passive
Temperature, deg C operational min ______ max ______
non-operational min ______ max ______
Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS
Location: ☒ Internal ☐ External ☐ Remote
Equipment ID/Function ☒ Pressurized ☐ Unpressurized
L,m 1 W,m 2 H,m ______ Stowed
L,m ______ W,m ______ H,m ______ Deployed
Launch mass, kg 300 - 1000
Consumables Types ______
Acceleration sensitivity, g min ______ max 10^{-5}

CREW REQUIREMENTS
Crew Size 1 Task Assignment Activation, Checkout, Monitor
Skills (See Table B)

SKILL	5					
LEVEL	2					
Hrs/Day	0.5					

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE
SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______
CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

1) Process requires 22 KWh/day, process is autonomous. 2) Transient acceleration 10^{-3}g to 10^{-5}g may be acceptable depending on duration and occurrence during the processing cycle. 3) Requires vacuum vent access or external mounting. Furnace modules may operate in a vacuum or pressurized helium mode. 4) May be sensitive to particulate or gaseous contamination, radioactifity and RF/magnetic fields; may emit gaseous/particulate contamination and generate RF/magnetic fields.

GDCD CODE 1214 ELEMENT NAME SPACE ISOTHERMAL FURNACE SYSTEM

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1990 INT. HRS ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ______ DAYS TOTAL SERVICES ______

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.5 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) 1990 INT. HRS. ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. are accommodated in -0400 facility
3. This is a 4 day mission. Crew tasks are: Activate/checkout, monitor, measure/record. Crew tasks are not additive to -0400 crew tasks.

TOTAL EVA HRS 0

Code: GDCD 1214 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Space Isothermal Furnace

Reference Documents:

1. GTI Corp User Fact Sheet

Narrative:

GTI has a JEA with NASA and was developing a multi-module furnace for isothermal processing of 220 separate samples at several different temperatures. Payload element objective, description, orbit, duration, size, mass, power, acceleration levels, crew size/time, and special considerations provided by Ref 1. Other data was derived such as crew skill, type and level.

Section 2.4

Discipline Industrial Services

GDCD ID NO.	PAYLOAD ELEMENT NAME
1300	Radiation Hardened Computer
1301	Full-Body Teleoperator
1302	Gamma Ray Astronomy
1303	Plants in Controlled Environment Life Support Systems (CELSS)
1304	Controlled Environment Life Support Systems (CELSS)
1305	Communication Satellite Service/Handling

PAYLOAD ELEMENT NAME
Radiation Hardened Computer

CODE G D C D 1 3 0 0

CONTACT

Name / Address: W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone: (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 1825

OBJECTIVE

Provide a radiation hardened computer.

TYPE

- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 9

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

DESCRIPTION

CODE G D C D 1 3 0 0

ORBIT CHARACTERISTICS

Apogee, km Any ______ Perigee, km Any ______ Tolerance + ______ -

Inclination, deg Any ______ Tolerance + ______ -

Nodal Angle, deg ______ Ephemeris Accuracy, m ______

Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ______

Pointing accuracy, arc sec ______ Field of view, deg ______

Pointing Stability (Jitter) arc sec/sec ______

Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	200	24
Standby		
Peak		

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☐ Realtime ☐ Offline ☐ Other ______

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______

☐ On-Board Data Processing Required

Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______

Film (Amount) ______ Voice (Hrs/Day) ______

Live TV (Hrs/Day) ______ Other ______

On-Board Storage (MBIT) ______

Data Dump Frequency (Per Orbit) ______

Recording Rate (KBPS) 1000 ______ Downlink Frequency (MHZ) ______

CODE GDCD1300

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 0.6 W,m 0.5 H,m 0.4 Stowed

L,m 0.6 W,m 0.5 H,m 0.4 Deployed

Launch mass, kg 50

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☒ YES ☐ NO Reason Install/Remove Hrs/EVA 4

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Crew time (internal) estimate 8 hrs (4 set-up, 4 deactivate). No routine man-involvement is foreseen.

GOCD CODE 1300 ELEMENT NAME RADIATION HARDENED COMPUTER

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER* ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1990 INT. HRS 4 EVA HRS 2 EVA CREW 1

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

____ HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☒ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) 1995 INT. HRS. 4 EVA HRS 2 EVA CREW 1

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

*Free flyer accommodation is an alternate mode, and if used will require re-evaluation of all requirements.

1. Installation and initial checkout.
3. This payload element is radiation hardened, general purpose computer developed and provided by private firm as a resource to Space Station and users. Assumed to be time shared. Man not required for normal operations peculiar to this payload element.

TOTAL EVA HRS 4

Code: GDCD 1300

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Radiation Hardened Computer .

Reference Documents:

1. Control Data Corporation, User Fact Sheet

Narrative:

Ref 1 letter showed intent to provide an experiment for a radiation hardened computer. Control Data also provided the economic portion of the fact sheet.

The mission date was selected consistent with the assumption that the resource would be required for the earliest Space Station application.

All the remaining data was derived.

PAYLOAD ELEMENT NAME
Full-Body Teleoperator

CODE G D C D 1 3 0 1

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1995
No. of flights 1
Duration of Flight, days 1460

OBJECTIVE

Provide the space station with a substantial fraction of EVA functionality without crew members leaving pressurized habitat chambers.

TYPE

- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 9

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

DESCRIPTION

Movement sensors attached to the limbs, head, and fingers of a crew member directly control A "humanoid" jointed robot outside the station. Weightlessness provides the crew member with full mobility. The robot is equipped with thrusters, controlled by the crew member for mobility. A TV camera is mounted on the "head" of the robot with control by the crew member's head movements.

CODE G D C D 1 3 0 1

ORBIT CHARACTERISTICS

Apogee, km Any ____ Perigee, km Any ____ Tolerance + ____ -

Inclination, deg Any ____ Tolerance + ____ -

Nodal Angle, deg ____ Ephemeris Accuracy, m ____

Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ____

Pointing accuracy, arc sec ____ Field of view, deg ____

Pointing Stability (Jitter) arc sec/sec ____

Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	500 - 1000	
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☐ Realtime ☐ Offline ☐ Other ____

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____

☐ On-Board Data Processing Required

Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____

Film (Amount) ____ Voice (Hrs/Day) ____

Live TV (Hrs/Day) ____ Other ____

On-Board Storage (MBIT) ____

Data Dump Frequency (Per Orbit) ____

Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 1 3 0 1

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☒ Internal ☒ External ☒ Remote

Equipment ID/Function ☒ Pressurized ☒ Unpressurized

L,m 1.0-1.26 W,m 1.0-126 H,m 1.0-126 Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg <300

Consumables Types Thruster Fuel

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions 1) Stowed equipment size does not include unpressurized equipment occupying less than 2 meters length packaged for delivery in Shuttle cargo bay. 2) An optical window may be required. 3) May generate particulate and gaseous contamination and RF/magnetic fields; may be sensitive to RF/magnetic fields. 4) Robot and teleoperator controls must be stored when not in use. Robot storage needs protection from extreme thermal environment. 5) Operated by 1-man (skill/level=5/3). Crew hours for operation are accounted for under payload using this equipment.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1301 ELEMENT NAME FULL-BODY TELEOPERATOR

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1995 INT. HRS 24 EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

____ HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☒ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) 1999 INT. HRS. 24 EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Initial checkout
3. This payload element provides a portion of the Space Station EVA function. A specially trained crew member in the pressurized area controls the operation of a robot outside the station. The EVA function as described could be used by many payload elements periodically after it becomes available (est. 1995). Crew hours for operation are accounted for under payload elements using this equipment. No crew time peculiar to this payload element.
5. Deactivate.

TOTAL EVA HRS 0

Code: GDCD 1301

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Full-Body Teleoperator

Reference Documents:

1. Glob Enterprises, Space Products Division, User Fact Sheet

Narrative:

Ref 1 provides the data for this payload element, including special considerations. The date was selected consistent with the user desires. The full-bodied teleoperator would provide the Space Station with a substantial fraction of EVA functions without crew members leaving the pressurized volume. Movement systems attached to IVA crewman limbs, head, fingers directly control a jointed robot outside.

The LXWXH measurements were derived by taking the cube root of Ref 1 pressurized volume. Cres skill/level and time were derived.

PAYLOAD ELEMENT NAME
Gamma Ray Astronomy

CODE
G D C D 1 3 0 2

CONTACT
Name: W. Hardy/J. Peterson MZ 21-9530
Address: General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 60

TYPE
- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 9

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 5

OBJECTIVE

Gamma ray spectroscopic studies of high energy astrophysical sites.

DESCRIPTION

GDCD 0030 gamma ray observatory probably could accommodate this payload element which has been identified by a commercial institution.

CODE G D C D 1 3 0 2

ORBIT CHARACTERISTICS

Apogee, km 400 Perigee, km 400 Tolerance + 50 - 50
Inclination, deg 0 Tolerance + 28.5 - 0
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☒ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec >360 Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	200	10
Standby		
Peak		

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) 10 Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description
Digital and analog recorders, display/keyboard, computer, timing

Data Types: ☒ Analog ☒ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

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CODE G D C D 1 3 0 2

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 3 W,m 3 H,m 3 Stowed
L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 1000 - 3000

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

1) Payload element desires orbit altitudes as low as possible with near equatorial inclination; will accept any orbit altitude/inclination below charged particle belts. 2) Down link digital data rate 100,000 bps. 3) Emits gaseous and radioactive contamination; sensitive to radioactive contamination. 4) LN_2 logistic support. 5) Prefers isolation from nearby equipment mass.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1302 ELEMENT NAME GAMMA RAY ASTRONOMY

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1990 INT. HRS ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ______ DAYS TOTAL SERVICES ______

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

______ HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☒ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

This payload is representative of a class of commercial users interested in basic research in space.

1. Accommodation is based on capability of GRO (GDCD-0030)

5. Deactivation would occur at next scheduled servicing (1991)

TOTAL EVA HRS 0

Code: GDCD 1302 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Gamma-Ray Astromony

Reference Documents:

1. Bell Labs, User Fact Sheet

Narrative:

Free-flyer accommodation is assumed based on compatibility with Gamma-Ray Observatory GDCD 0030.

The launch date was derived based on the assumption that the experiment equipment would be available at the earliest opportunity since balloon flights are currently being made.

The height dimension is an estimate.

This payload element is assumed to be representative of a class of commercial users who desire to conduct basic research in space.

PAYLOAD ELEMENT NAME
Plants in Controlled Environ LSS

CODE
G D C D 1 3 0 3

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days >180

TYPE

☐ Science & Applications (non-commercial)
☒ Commercial
☐ Technology Development
☐ Operations

Type Number (see Table A) 9

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

OBJECTIVE

Initially develop facilities for supporting algae and plant life, and later use facilities in constructing controlled environment life support systems (CELSS).

DESCRIPTION

The initial phase (1990) would involve: 1) test equipment and procedures for monitoring gas and nutrient fluxes in algae and plant growth chambers, 2) determine the characteristics of algae culture growth in the low gravity and high energy radiation condition space, 3) test algae native models for CELSS. GDC 0341 CELSS could accommodate this payload element. The later commercial CELSS (1995) is described in GDCD 1304 CELSS.

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CODE
G D C D 1 3 0 3

ORBIT CHARACTERISTICS
Apogee, km Any Perigee, km Any Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION
View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER
☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS
Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description
General Purpose Computer
Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

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CODE GDCD1303

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed
L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg ______

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1 Task Assignment Preprogrammaged and Real Time Experiment Control; Maintenance

Skills (See Table B)

SKILL	2					
LEVEL	2					
Hrs/Day	0.2					

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg. ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

1) May require access to filtered sunlight. 2) May require constant rotation for artificial gravity or a range of artificial gravity levels. 3) Storage of H_2O, O_2, CO_2, N_2 and experiment supplies. 4) May be sensitive to particulate and gaseous contamination, radioactivity and RFI magnetic fields; may emit gaseous and particulate contamination.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1303 ELEMENT NAME PLANTS IN CELSS

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1990 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.2 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) 1990 INT. HRS. ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Activation assumed as part of station OPS
3. Accommodated by GDCD-0341. Added crew time charged to this payload element for peculiar activities only.
5. Deactivation part of station OPS

TOTAL EVA HRS 0

Code: GDCD 1303

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Plants in Controlled Environment Life Support Systems (CELSS)

Reference Documents:

1. Texas A&M University, User Fact Sheet

Narrative:

The Ref 1 fact sheet data described two payload elements. The first develops a facility for supporting algal and plant life. The second (GDCD 1304) uses the facility in constructing commercial CELSS. Power and weight provided in the fact sheet primarily applies to the commercial facility.

The 1990 date is extrapolated from fact sheet based similar use in the Space Stations during the same period.

The Ref to GDCD 0341 accommodation is derived by similarity of objectives/descriptions.

Crew related data is derived.

All other data is from Ref 1.

PAYLOAD ELEMENT NAME
Controlled Environment LSS

CODE G D C D 1 3 0 4

TYPE

- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 9

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1996
No. of flights 1
Duration of Flight, days >180

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

OBJECTIVE

Provide space station controlled environment life support system (CELSS) based on plant experiments.

DESCRIPTION 1) Reference GDCD 1303 for development of this payload element. 2) Weight, volume and power estimates for this payload element are defined for each crew member supported. 3) Operational CELSS may be sensitive to particular and gaseous contamination, radioactivity and RF/magnetic fields. CELSS may emit gaseous and particular contamination. 4) Accommodation of CELSS should consider need for temperature and light control. 5) GDCD 0342 dedicated cells module, could accommodate this payload element.

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CODE
G D C D 1 3 0 4

ORBIT CHARACTERISTICS
Apogee, km Any Perigee, km Any Tolerance + -
Inclination, deg Any Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known)
Pointing accuracy, arc sec Field of view, deg
Pointing Stability (Jitter) arc sec/sec
Special Restrictions (Avoidance)

POWER
☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	300	
Standby		
Peak	1000 - 2500	

☐ Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) Frequency (MHZ)
☒ On-Board Data Processing Required
Description
General Purpose Computer

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day
Film (Amount) Voice (Hrs/Day)
Live TV (Hrs/Day) Other
On-Board Storage (MBIT)
Data Dump Frequency (Per Orbit)
Recording Rate (KBPS) Downlink Frequency (MHZ)

CODE G D C D 1 3 0 4

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☒ Internal ☐ External ☐ Remote

Equipment ID/Function ☒ Pressurized ☐ Unpressurized

L,m 2.1 W,m 2.1 H,m 2.1 Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 1500

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1

Task Assignment Preprogrammed and Real Time Control; Maintenance

Skills (See Table B)

SKILL	2					
LEVEL	2					
Hrs/Day	0.2					

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

1) Provision for locally maintained constant rotation without overall Space Station rotation.
2) Storage and support requirements for live specimens are TBD.

GDCD CODE 1304 ELEMENT NAME CELSS

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1996 INT. HRS ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ______ DAYS TOTAL SERVICES ______

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.2 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) 1996 INT. HRS. ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Activation part of station OPS
3. Accommodated by GDCD-0342. This payload element charged only for additional crew time for peculiar objectives.
5. Deactivation part of station OPS

TOTAL EVA HRS 0

Code: GDCD 1304

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Controlled Environment Life Support System (CELSS)

Reference Documents:

1. Texas A&M University, User Fact Sheet

Narrative:

The Ref 1 fact sheet data described two payload elements. The first develops a facility for supporting algal and plant life (Ref GDCD 1303). The second payload element uses the facility in constructing commercial CELSS. LXWXH data is derived from this cube root of the pressurized volume and applies to each crew member. The reference to GDCD 0342 accommodation is derived from similarity of objective/descriptions.

All other data is from Ref 1.

PAYLOAD ELEMENT NAME
Communications Satellite Service/Handling

CODE G D C D 1 3 0 5

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1992
No. of flights ____
Duration of Flight, days 30

TYPE
- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 9

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 10

OBJECTIVE

Provide service to increase life and enhance system operations for larger, more complex commercial communications satellites (1500 to 2500 Kg).

DESCRIPTION

Prelaunch activities for assembly, deployment and testing of large antennas. Refuel of liquid propulsion system. Replace and/or reconfigure communications payload elements. Test new sub-systems. Deploy and handle satellite (Ref. GDCD 2504 &2505 for on-orbit for communication service & handling of satellite). New technology experimental/development for communication satellites is also identified by the user (Ref. GDCD 1106 for antenna development).

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CODE
G D C D 1 3 0 5

ORBIT CHARACTERISTICS

Apogee, km Any ______ Perigee, km Any ______ Tolerance + ______ -
Inclination, deg 28.5 ______ Tolerance + ______ -
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec ______ Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	______	______
Standby	______	______
Peak	______	______

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

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CODE G D C D 1 3 0 5

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed
L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg ______

Consumables Types Satellite Propellants

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size ______ Task Assignment ______

Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Periodic service and configuration changes required for spacecraft (e.g., propellant or replacement of spacecraft components). EMI/RFI protection required during comm P/L testing. Antenna test may need access to orbital objects or Earth targets with pointing accuracy of 0.5 deg, stability up to 20 arc/sec and power up to 500 watts.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 1305 ELEMENT NAME COMMOM. SAT SERVICE/HANDLING

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1992 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   ____ HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) 1992 INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1, 3 and 5. Accommodation requirements accounted for under GDCD-2504, 2505 and 1106.

TOTAL EVA HRS 0

Code: GDCD 1305

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Communications Satellite Servicing and Handling

Reference Documents:

1. RCA Astro-Electronics, User Fact Sheet

Narrative:

Ref 1 describes two types of user activities.

a. Handling of large communication satellites on orbit
b. New technology experimentation/development for communications satellites.

GDCD 2504 OTV Payload Handling and GDCD 2505 Payload Servicing and Repair can accommodate handling requirements of this payload element, while GDCD 1106 Large Deployable Antenna accommodates antenna development objectives.

Mission data and crew related data for this payload element was derived.

TECHNOLOGY DEVELOPMENT MISSIONS

Section 3.1

Discipline Materials & Structures

GDCD ID NO.	PAYLOAD ELEMENT NAME
2001	Strain and Acoustic Sensors
2002	Spacecraft Materials Technology
2003	Materials and Coatings
2004	Thermal Shape Control
2005	Dynamics of Flimsy Structures
2006	Active Optics Technology
2007	Large Structures Technology

PAYLOAD ELEMENT NAME
Strain and Acoustic Sensors

CODE G D C D 2 0 0 1

CONTACT

Name W. Hardy/J. Peterson MZ 21-9530

Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 3650+

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 10

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

OBJECTIVE

Develop technology necessary to examine spacecraft structures and provide long-term structural verification through advanced nondestructive evaluation. Test such systems on early spacecraft missions and improve to meet monitoring needs.

DESCRIPTION

Advanced acoustic emission sensors designed and built into the spacecraft structure will be monitored during the mission by a preprogrammed computer. The sensors will be developed and tested and will take advantage of our current R&D program output to provide state-of-the-art sensors. Additional sensors designed to monitor strain with acoustics and fiber-optic interferometric sensors which have been developed at LaRC will be structurally integrated as well.

CODE G D C D 2 0 0 1

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + –
Inclination, deg Any Tolerance + –
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☒ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	100	4
Standby	0	
Peak	100	

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description
Monitor Acoustics

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 1.0 Downlink Frequency (MHZ) ____

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CODE G D C D 2 0 0 1

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 50

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1 Task Assignment Monitor Sensor Condition

Skills (See Table B)

SKILL	1					
LEVEL	2					
Hrs/Day	0.1					

EVA ☒ YES ☐ NO Reason Sensor Replacement Hrs/EVA 120

SERVICING/MAINTENANCE

SERVICE: Interval, days 180 Consumables, kg ______

Returnables, kg ______ Man Hours 6

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Space Station provides necessary long term exposure to the space environment as well as access for specimen removal, replacement, and insitu testing. At some point this would cease to be an experiment and would be incorporated as part of the station. Reconfiguration is inherent in servicing.

GDCD CODE 2001 ELEMENT NAME STRAIN AND ACOUSTIC SENSORS

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1990 INT. HRS ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 180 DAYS TOTAL SERVICES 20

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

☐ NOT APPLICABLE ______ EVA HRS PER SERVICE 6

EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.1 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Original placement of sensors part of station OPS
2. Replacement/inspection of sensors 1 day every 6 mos.
3. Operational assurance monitoring
4. Reconfiguration inherent in servicing
5. Sensors not removed from structure - incorporated as part of basic station.

TOTAL EVA HRS 120

Code: GDCD 2001

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Strain and Acoustic Sensors

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982, attachment A, p 41

Narrative:

The payload element objective, description, EVA reasons, and special considerations are based on Ref 1.

All other data is derived.

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title: Space Structures Technology Development

Langley Contact: Joseph Heyman
MS 499/ X3418

Experiment Title: Spacecraft Strain & Acoustic Emission Sensors

Mission Objectives: Develop technology necessary to examine spacecraft structures and provide long-term structural verification through advanced Nondestructive Evaluation (NDE). Test such systems on early spacecraft missions and improve to meet monitoring needs.

Mission Description: Advanced acoustic emission sensors designed and built into the spacecraft structure will be monitored during the mission by a preprogramed computer. The sensors will be developed and tested on the ground and will take advantage of our current R&D program output to provide state-of-the-art sensors. Additional sensors designed to monitor strain with acoustics and fiber-optic interferometric sensors which have been developed at LaRC will be structurally integrated as well.

Benefit:

The life of the Spacestation may very well depend on integrated NDE with the structural design and Quantitatively monitoring material/structural properties during long-term space environment exposure (environment plus control). Proper monitoring may both identify problems before they become critical as well as prevent problems caused by improper control technology.

Justification: Need for real spacestation environment and long duration tests to evaluate methodology.

Mission Requirements and Capability: Spacestation

Space Station vs. Free Flyer:

PAYLOAD ELEMENT NAME
Spacecraft Materials Technology

CODE G D C D 2 0 0 2

CONTACT
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Address General Dynamics Convair Division
P.O. Box 85357
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Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1991
No. of flights 1
Duration of Flight, days 3300+

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 10

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 6

OBJECTIVE

To provide a technology data base for long term use of advanced materials in space.

DESCRIPTION

The proposed mission would provide a unique opportunity to develop a long term space enviornmental durability data base on advanced thermal control coatings, adhesives, composites, and polymer films. Specific experiments would be developed to evaluate the effects of each exposure parameter, both singly and combined, on the properties of these materials. Insitu evaluation of properties could be performed.

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CODE
G D C D 2 0 0 2

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 2 0 0 2

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed
L,m 5 W,m 1 H,m 0.1 Deployed

Launch mass, kg 150

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1 Task Assignment Monitor and Test Specimens

Skills (See Table B)

SKILL	1					
LEVEL	2					
Hrs/Day	0.1					

EVA ☒ YES ☐ NO Reason Inspection/Service Hrs/EVA 100

SERVICING/MAINTENANCE

SERVICE: Interval, days 180 Consumables, kg ______
Returnables, kg ______ Man Hours 5

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Space Station required to provide access for specimen removal, replacement, and periodic insitu testing. Low power essential, level undetermined. Reconfiguration is inherent in servicing.

GDCD CODE 2002 ELEMENT NAME SPACECRAFT MATERIALS TECHNOLOGY

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1991 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 180 DAYS TOTAL SERVICES 20

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☐ NOT APPLICABLE ____ EVA HRS PER SERVICE 5

   EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.1 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Experimentation starts in 1991. Setup time station OPS
2. 5 hours 2 times a year are allocated for sample placement/retrieval
3. Operational support for examination and measurement
4. Reconfiguration inherent in servicing.
5. Experimentation runs past year 2000.

TOTAL EVA HRS 100

Code: GDCD 2002

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Spacecraft Materials Technology

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation meeting NASA Hq., 14-15 Sept 1982

Narrative:

Payload element objective, description, EVA reasons and special considerations are based on Ref 1.

All other data is derived.

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title:
Spacecraft Materials Technology

Langley Contact:
D. R. Tenney, W. S. Slemp, G. F. Sykes

Experiment Title:

Mission Objectives:
To provide a technology data base for long term use of advanced materials in space

Mission Description:
The proposed mission would provide a unique opportunity to develop a long term space environmental durability data base on advanced thermal control coatings, adhesives, composites, and polymer films. Specific experiments would be developed to evaluate the effects of each exposure parameter, both singly and combined, on the properties of these materials. Insitu evaluation of properties could be performed.

Benefit:
Long term exposure data is not available, therefore a data base would be generated that would provide a basis for more efficient space structure design. The generated data would provide verification for ongoing materials exposure programs in ground-based facilities.

Justification:
Long term laboratory simulation experiments are expensive and limited because a complete space environment consisting of extreme ultraviolet, vacuum, atomic oxygen and thermal cycling cannot be duplicated in the Earth-based laboratories.

Mission Requirements and Capability:
Space station is required to provide access for specimen removal, replacement and periodic insitu testing. Power (level TBD) would be essential. Orbit requirements designed to provide maximum environmental expsoure.

Space Station vs. Free Flyer:

PAYLOAD ELEMENT NAME
Materials and Coatings

CODE G D C D 2 0 0 3

TYPE
- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 10

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
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Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1991
No. of flights 1
Duration of Flight, days 3300+

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 8

OBJECTIVE To provide a technology base for the production of structural and insulating materials, and optical, thermal, and absorbing surface coatings capable of sustained performance in the space environment.

DESCRIPTION Data will be obtained on the effect of the space environment on critical physical properties of materials and coatings for use in space projects. Specific areas of investigation include the degradation of the reflectivity of mirror/antenna metallic coatings as well as the decrease in the absorptivity of low-scatter optical black surfaces when exposed to solar illumination and solar wind/cosmic ray high energy particle fluxes. Meteoroid venting of the interstitial spaces of thermal insulating materials; decreases in the Young's Modulus of resin-matrix structural composite materials due to cosmic ray damage and vacuum effects; and particle contamination of the thermal-control coatings applied to heat pipes are also technological concerns.

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OF POOR QUALITY

CODE
G D C D 2 0 0 3

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ______ - ______

Inclination, deg Any Tolerance + ______ - ______

Nodal Angle, deg ______ Ephemeris Accuracy, m ______

Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ______

Pointing accuracy, arc sec ______ Field of view, deg ______

Pointing Stability (Jitter) arc sec/sec ______

Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	______	______
Standby	______	______
Peak	______	______

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☐ Realtime ☐ Offline ☐ Other ______

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______

☐ On-Board Data Processing Required

Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______

Film (Amount) ______ Voice (Hrs/Day) ______

Live TV (Hrs/Day) ______ Other ______

On-Board Storage (MBIT) ______

Data Dump Frequency (Per Orbit) ______

Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

CODE G D C D 2 0 0 3

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m 10 W,m 5 H,m 0.2 Deployed

Launch mass, kg 250

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1 Task Assignment Monitor and Test Specimens

Skills (See Table B)

SKILL	1					
LEVEL	2					
Hrs/Day	0.1					

EVA ☒ YES ☐ NO Reason Inspection/Service Hrs/EVA 100

SERVICING/MAINTENANCE

SERVICE: Interval, days 180 Consumables, kg ______

Returnables, kg ______ Man Hours 5

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions Orbit inclination and altitude will be chosen to allow the requisite solar illumination and high-energy particle flow rate. Due to the large dimensions anticipated for the surface coatings used in future space projects, the area of the samples investigated in the proposed mission must be on the order of many square meters. Since optical spectrometers of high positional sensitivity will be utilized in the reflectivity and absorptivity measurements, a high degree of stability will be required of the Space Station. Service is for sample retrieval. Reconfiguration is inherent in servicing.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 2003 ELEMENT NAME MATERIALS AND COATINGS

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1991 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 180 DAYS TOTAL SERVICES 20

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☐ NOT APPLICABLE ____ EVA HRS PER SERVICE 5

   EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.1 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Experimentation starts in 1991. Set up time part of Station OPS
2. 5 hours 2 times a year are allocated for sample placement/retrieval
3. Operational support for examination and measurement.
4. Reconfiguration inherent in servicing.
5. Experimentation runs past year 2000

TOTAL EVA HRS 100

Code: GDCD 2003

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Materials and Coatings

Reference Documents:

1. Technology Development Missions, NASA Space Station NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982, attachment A, p 67

Narrative:

Payload element objective, description, EVA reasons, and special considerations are based on Ref 1.

All other data is derived.

MATERIALS AND COATING TECHNOLOGY

I. Mission Objective

To provide a technology base for the production of structural and insulating materials, and optical, thermal, and absorbing surface coatings capable of sustained performance in the space environment.

II. Mission Description

Data will be obtained on the effect of given characteristics of the space environment on critical physical properities of materials and coatings anticipated for use in future space projects. Specific areas of investigation include the degradation of the reflectivity of mirror/antenna metallic coatings as well as the decrease in the absorbtivity of low-scatter optical black surfaces when exposed to solar illumination and solar wind/cosmic ray high energy particle fluxes. Meteoroid venting of the interstitial spaces of thermal insulating materials; decreases in the Young's Modulus of resin-matrix structural composite materials due to cosmic-ray damage and vacuum effects; and particle contamination of the thermal-control coatings applied to heat pipes are also technological concerns. The developed Mission facility will also have the capbility for investigations in the area of space polymer chemistry.

III. Benefit

Since the proposed investigation is involved with common materials and coatings used in varied components of future space missions, the resulting data will be instrumental in developing the enabling technology associated with same missions.

IV. Justification

Based on the Mission specifications, it is apparent that the fundamental requirement for mission operation is long-term exposure to the particle and radiation fluxes only obtained the space vacuum environment. A multi-year Mission lifetime will allow the establishment of time-integrated cumulative effects on the measured physical parameters. Such a procedure represents a substantial improvement over the time-accelerated ground-based testing. Due to the large number of material/coating subsystems comprising the total mission, manned interaction is needed for control and data acquistion.

V. Mission Requirements and Capabilites

A) Orbital Parameters- Orbit altitude and inclination angle will be chosen to allow the requsite solar illumination and high-energy particle flow rate.

B) Mass, Volume, Operational Envelope- Due to the large dimensions anticipated for the surface coatings used in future space projects, the area of the samples investigated in the proposed mission must be on the order of many square meters.

C) Power- The power requirements will depend upon the exact characteristics of the subsystem technology and measurement devices employed.

D) Thermal Control- TBD

E) Attitude, Stabilization- Since optical spectrometers of high positional sensitivity will be utilized in the reflectivity and absorbtivity measurements, a high degree of stability will be required of the space station.

F) Viewing- See comment on Orbital Parameters.

G) Environmental Constraints- none.

H,I,J) Data Management, Communications, Crew Timeline, Operations Schedule, Maintenance, Lifetime- TBD

VI. Space Station vs. Free Flyer

Due to the large physical dimensions, long timescale, and diverse subsystem experiments requiring manned interaction, characteristic of this mission, it can be argued that a Space station would be the most suitable location for the mission operation.

PAYLOAD ELEMENT NAME
Thermal Shape Control

CODE G D C D 2 0 0 4

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1993
No. of flights 1
Duration of Flight, days 550

OBJECTIVE

To determine the feasibility of controlling shape distortion by onboard heating.

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 10

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 9

DESCRIPTION

A large flexible panel will be attached to the Space Station. Heaters will be mounted to the panel at a number of locations. Sensors located on the panel will detect deviations from the required shape and trigger the heaters to generate a temperature distribution in the panel which will offset the unwanted distortions.

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CODE GDCD2004

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ___ -
Inclination, deg Any Tolerance + ___ -
Nodal Angle, deg ___ Ephemeris Accuracy, m ___
Escape dV Required, m/s ___

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ___
Pointing accuracy, arc sec ___ Field of view, deg ___
Pointing Stability (Jitter) arc sec/sec ___
Special Restrictions (Avoidance) ___

POWER

☒ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	3000	
Standby	0	
Peak	6000	

☐ Continuous

Voltage, V ___ Frequency, Hz ___

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other ___
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ___ Frequency (MHZ) ___
☐ On-Board Data Processing Required
Description ___

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ___
Film (Amount) ___ Voice (Hrs/Day) ___
Live TV (Hrs/Day) ___ Other ___
On-Board Storage (MBIT) ___
Data Dump Frequency (Per Orbit) ___
Recording Rate (KBPS) 1.0 Downlink Frequency (MHZ) ___

CODE G D C D 2 0 0 4

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m 20 W,m 10 H,m 0.2 Deployed

Launch mass, kg 1000

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1 Task Assignment ______

Skills (See Table B)

SKILL	5					
LEVEL	2					
Hrs/Day	0.1					

EVA ☒ YES ☐ NO Reason Assembly/Disassembly Hrs/EVA 16

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

GOCD CODE 2004 ELEMENT NAME THERMAL SHAPE CONTROL

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1993 INT. HRS ____ EVA HRS 12 EVA CREW 2

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.1 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) 1994 INT. HRS. ____ EVA HRS 4 EVA CREW 2

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Assembly and checkout of panel
3. Operational support for control and measurement
5. Removal of panels

TOTAL EVA HRS 16

Code: GDCD 2004

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Thermal Shape Control

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982

Narrative:

Payload element objective, description, and EVA reasons are based on Ref 1.

All other data is derived.

Code: GDCD 2004

PAYLOAD ELEMENT SYNTHESIS

Mission Title: Spacecraft Control Technology Development

Langley Contact: H. M. Adelman

Experiment Title: Thermal Shape Control Technology

Mission Objectives: Determine the feasibility of controlling shape distortion by on-board heating.

Mission Description: A large flexible panel will be attached to the Space Station. Heaters will be mounted to the panel at a number of locations. Sensors located on the panel will detect deviations from the required shape and trigger the heaters to generate a temperature distribution in the panel which will offset the unwanted distortions.

Benefit: Control of distortions by thermal means has these benefits relative to control by applied forces: Thermal loads are self-equilibrating and their use avoids possible drift and orientation changes associated with unbalanced forces; solar heating and on-board generated heat is available to activate the heaters; the stresses in the panel resulting from the heat loads would be smaller than those associated with applied forces.

Justification: Verification of the concept of thermal shape control requires a long duration mission in a low-g environment. Ground tests and Shuttle flight tests are precluded because of inadequate facilities to simulate precise conditions of sustained orbital heating and to accommodate the large-sized test article required.

Mission Requirements and Capability: The experiment requires a highly variable thermal load environment characteristic of low earth orbit with periodic shading of the panel by the Space Station.

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PAYLOAD ELEMENT NAME
Dynamics of Flimsy Structures

CODE G D C D 2 0 0 5

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1994
No. of flights 1
Duration of Flight, days 1460

OBJECTIVE Determine dynamic characteristics of large structural systems for use in orbital opeations where static load requirements are small. The dynamic stiffness and damping characteristics of structures such as antenna dishes and manipulator systems which would be nonfunctional in 1-g will be studied.

TYPE
- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 10

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

DESCRIPTION Candidate structures would be deployed or erected using Space Station as stable platform. General size class would be 30 to 100 meters. Dynamic inputs would be provided and response data measured using Space Station as a laboratory. Experiment duration may be one week or more per test period as the structures are modified and expanded. Total of 4 year mission time.

CODE G D C D 2 0 0 5

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance ± –
Inclination, deg Any Tolerance ± –
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☒ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	1000	24
Standby	0	
Peak	1000	

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☒ Uplink Req.: Command Rate (KBS) 1.0 Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 1.0 Downlink Frequency (MHZ) ____

CODE G D C D 2 0 0 5

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m 100 W,m 200 H,m 2.5 Deployed

Launch mass, kg 1000

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1 Task Assignment Monitor Structure Dimensions

Skills (See Table B)

SKILL	1					
LEVEL	1					
Hrs/Day	0.1					

EVA ☒ YES ☐ NO Reason Fab/Disassembly Hrs/EVA 58

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Space Station mounted optical measurement devices will be required. 10 day experiment time period, conducted 3 times per year for 4 years (12 repetitions). Used by experiments GDCD 2201, 2202, 2203, 2204, 2502. Power required continuously during experiment period.

GDCD CODE 2005 ELEMENT NAME DYNAMICS OF FLIMSY STRUCTURES

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1994 INT. HRS ____ EVA HRS 50 EVA CREW 2

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.1 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) 1998 INT. HRS. ____ EVA HRS 8 EVA CREW 2

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. 4 years span time includes use by GDCD-2201, 2202, 2203, 2204, 2502
3. Operational support for control and measurement
5. Prepare structure for TMS Deorbit

TOTAL EVA HRS 58

Code: GDCD 2005

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Dynamics of Flimsy Structures

Reference Documents:

1. Technology Development Missions Space Station NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982, attachment A p 40

2. GDC Report CASD-ASP77-017, "SCAFEDS Final Report", Vol. II, Study Results", 26 May 1978

Narrative:

Payload element flight duration, objective, description, and EVA reasons are based on Ref 1.

The test structure size of 100 by 20 by 2.5 meters is based on Ref 1. The structure design is based on SCAFEDS technology and employs graphite composite truses built in space by a Beam Builder machine (Ref 2).

The mass of the Beam Builder, assembly fixtures, etc., is not included in the mass estimate in the payload element data sheets.

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title:
Space Structures Technology Development--
Static/Dynamic Testing

Langley Contact:
B. R. Hanks

Experiment Title:
Dynamics of Lightly Loaded Structures

Mission Objectives:
Determine dynamic characteristics of large structural systems for use in orbital operations where static load requirements are small. The dynamic stiffness and damping characteristics of structures such as antenna dishes and manipulator systems which would be non-functional in 1-G will be studied.

Mission Description:
Candidate structures would be deployed or erected using space station as stable platform. General size class would be 30-100 m. Dynamic inputs would be provided and response data measured using space station as a laboratory. Experiment duration may be one week or more.

Benefit:
Building orbiting space structures of anything other than flimsy components may be unnecessary provided sufficient confidence in such components can be developed in flight experiments. Substantial reductions in launch costs and increases in the utility of large spacecraft may be realized through the use of ultra-light structures.

Justification:
For stated benefits to accrue, methods of predicting large dynamic motions and behavior of flimsy structures are needed. The inherent effects of gravity make any Earth-bound study of such structures invalid. The sizes required preclude 0-G aircraft flights.

Mission Requirements and Capability:
Requires 0-G test environment for one week or more. Structural sizes up to 100m involved for up to one week or more. Space station mounted optical measurement devices are necessary.

Space Station vs. Free Flyer:
Space station provides controlled base from which measurements are made. Eliminates need for flight control system which would likely be difficult or impossible to preclude from adverse effects on experiment. Reduces cost considerably.

PAYLOAD ELEMENT NAME
Active Optics Technology

CODE GDCD2006

TYPE
- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 10

CONTACT
Name / Address: W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1994
No. of flights 1
Duration of Flight, days 1000

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

OBJECTIVE

To provide a technology base for the operation and construction of large-aperture segmented mirrors having high surface accuracy optical figure.

DESCRIPTION The proposed mission will investigate critical technological issues germane to the use of large multi-segmented active reflectors in future space projects. Key areas of experimentation are maintenance of surface figure and segment orientation through positional actuators and control algorithms; measurement of optical image quality through wavefront sensing and laser ranging techniques; deployment, erection, and mechanical vibration control of the truss support structure for the primary mirror; and, accurate angular pointing of the antenna assembly. Since the technological readiness of the assembled reflector will be confirmed by astronomical observations, technological issues relating to infrared detectors and associated cryogenic engineering; microwave receivers, and optical fibers will also be addressed.

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CODE
G D C D 2 0 0 6

ORBIT CHARACTERISTICS

Apogee, km LEO ______ Perigee, km LEO ______ Tolerance + ______ -
Inclination, deg Any ______ Tolerance + ______ -
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☒ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec ______ Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	1000	
Standby		
Peak		

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

CODE G D C D 2 0 0 6

THERMAL

☐ Active ☒ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed
L,m 16 W,m 12 H,m 12 Deployed

Launch mass, kg 10,000

Consumables Types Cryogens

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1 Task Assignment ______

Skills (See Table B)

SKILL	7					
LEVEL	2					
Hrs/Day	0.2					

EVA ☒ YES ☐ NO Reason Assy/Service/Remove e Hrs/EVA 58

SERVICING/MAINTENANCE

SERVICE: Interval, days 180 Consumables, kg ______
Returnables, kg ______ Man Hours 20

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Payload equipment will provide own pointing accuracy of 0.5 to 20 arc seconds. Provides technology base for space telescope systems such as large deployable reflector.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 2006 ELEMENT NAME ACTIVE OPTICS TECHNOLOGY

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1994 INT. HRS 12 EVA HRS 24 EVA CREW 2

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 180 DAYS TOTAL SERVICES 5

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE 2

☐ NOT APPLICABLE ____ EVA HRS PER SERVICE 2

EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.2 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) 1996 INT. HRS. 12 EVA HRS 24 EVA CREW 2

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Assembly of mirror segments/back-up structure, mirror and positional actuators, secondary mirrior and instruments
2. Replenish cryogens
3. Evaluate mirror surface accuracy, observe long term effects and take astronomical data
5. Disassembly - see 1. above

TOTAL EVA HRS 58

Code: GDCD 2006

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Active Optics Technology

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982

2. Astrophysics Long-Term Program, GDC Document No. 10-004N, October 1980

Narrative:

General concept, timing, thermal design, and crew activities from Ref 1. Orbit parameters, orientation, size, and consumables from Ref 2. Mass derived from Ref 2 without spacecraft systems. Pointing capability from Ref 2.

All other data derived.

ACTIVE OPTICS TECHNOLOGY

I. Mission Objectives

To provide a technology base for the operation and construction of large-aperture segmented mirrors having high surface accuracy optical figure.

II. Mission Description

The proposed mission will investigate critical technological issues germane to the use of large multi-segmented active reflectors in future space projects. Key areas of experimentation are maintenance of surface figure and segment orientation through positional accuators and control algorithms; measurement of optical image quality through wavefront sensing and laser ranging techniques; deployment, erection, and mechanical vibration control of the truss support structure for the primary mirror; and, accurate angular pointing of the antenna assembly. Since the technological readiness of the assembled reflector will be confirmed by astronomical observations, technological issues relating to infrared detectors and associated cyrogenic engineering; microwave recievers, and optical fibers will also be addressed.

III. Benefit

Due to the generic nature of the optical technology research comprising the proposed mission, the results will be applicable to several types of NASA advanced space projects. Future high-spatial resolution remote sensing of earth resources and environmental conditions will require large diameter active reflectors. An active space-optics technological base will also be required for high bit-rate microwave communication antennae used on planetary spacecraft; solar heat collecting mirrors; and space telescope systems such as LDR, the Large Deployable Reflector.

IV. Justification

The Active Optics Technology Mission will require a prolonged time exposure to the space environment. Low gravity conditions are needed to insure realistic/useful technological data as well as to investigate capillary confinement techniques used to contain cyrogenic fluids. In order to demonstrate the lifetime of positional and accuating active mirror components and to investigate the time-integrated effects of particle radiation damage of infrared detectors, the Mission should have a several year duration. Optical technology concerns specifically related to the environment of space include the thermal deformation of the mirror figure due to solar illumination; the effect of solar wind torques on reflector pointing; and the effect of a vacuum on

resin-matrix structural composites. Manned interaction will be necessary for mission operation in the following areas: deployment and initial alignment of mirror panels and back-up structure; control of subsystem experiments; and development of the astronomical observing program.

V. Mission Requirements and Capabilities

A) Orbital Parameters- Orbit altitude and inclination angle should be chosen to maximize the potential of the astronomical observations.

B) Mass, Volume, Operational Envelope- In order to allow reasonable scaling of the technological data obtained in this mission, the test mirror should be composed of several panels each 1-4 meters in diameter.

C) Power- The power requirements are dependent upon the specific details of the instruments employed.

D) Thermal Control- Thermal insulation on the rear surface of the mirror panels and a passive sunshield will be used to regulate the reflector temperature. The space station need not provide thermal control.

E) Attitude, Stabilization- A high degree of positional stability will be required in order to make possible accurate wavefront contour measurements, CCD star tracker testing, laser ranging technology evaluation, and astronomical observations.

F) Viewing- see comment on Orbital Parameters

G) Environmental Constaints- none

H,I) Data Management, Communications, Crew Timeline- TBD

J) Operations Schedule, Maintenance, Lifetime- For the reasons detailed in section IV, a several year Mission lifetime is required.

VI. Space Station vs. Free Flyer

Due to the large physical dimensions, long timescale, and diverse subsystem experiments requiring manned interaction, characteristic of this Mission, it can be argued that a space station would be the most suitable location for the mission operation.

PAYLOAD ELEMENT NAME
Large Structures Technology

CODE GDCD2007

CONTACT Name Address
W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 2002
No. of flights 1
Duration of Flight, days 1100+

OBJECTIVE To provide a technology base for the design and analysis of very large space structures having dimensions larger than are compatible with Space Shuttle experiments.

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 10

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

DESCRIPTION

Assembly and testing of very large space structures will require utilization of the Space Station as a base for these activities. Maintaining a long lifetime stable platform for assembly and inertial structural characterization testing is important for the evolution of large structures technology. A large facility that can be used for assembly and environmental testing would be required on the Space Station. This facility would include data acquisition and analysis capabilities, mechanical operations support and maintenance capabilities, and a supply of goods and tools to allow modifications to large structure designs while on-orbit. Complete dynamic testing capabilities will be required to determine mode shapes, inertial properties, damping/influence coefficients, and other design parameters necessary to characterize the stability and dynamics of very large space structures. Payload based on SCAFEDS technology.

ORIGINAL PAGE IS
OF POOR QUALITY

CODE GDCD2007

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg Any Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known)
Pointing accuracy, arc sec Field of view, deg
Pointing Stability (Jitter) arc sec/sec
Special Restrictions (Avoidance)

POWER

☒ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	1000	
Standby	0	
Peak	1000	

☐ Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) Frequency (MHZ)
☐ On-Board Data Processing Required
Description

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day
Film (Amount) Voice (Hrs/Day)
Live TV (Hrs/Day) 4 Other
On-Board Storage (MBIT)
Data Dump Frequency (Per Orbit)
Recording Rate (KBPS) 1.0 Downlink Frequency (MHZ)

CODE G D C D 2 0 0 7

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m 1000 W,m 200 H,m 5 Deployed

Launch mass, kg 100,000

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2 Task Assignment Structural Testing

Skills (See Table B)

SKILL	1	1				
LEVEL	2	2				
Hrs/Day	0.2	0.2				

EVA ☒ YES ☐ NO Reason Fabrication Hrs/EVA 1500

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions Low inclination orbit for solar eclipses (thermal shock), high inclination (no eclipses) for thermal stabilization. Mass and volume thousands of kg, could require multi-shuttle launches. Operational envelope could be many km. A stable platform is necessary for assembly and testing. Possible isolation from the Space Station perturbations may be necessary. A real time data acquisition and analysis facility would be required. Payload specialists would be trained to assemble and test the large structures. Testing coordination between the onboard data facility and engineering teams on the ground would require detailed event timelines.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GOCD CODE 2007 ELEMENT NAME LARGE STRUCTURES TECHNOLOGY

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 2002 INT. HRS ____ EVA HRS 1500 EVA CREW 2

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.4 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Platform construction over 3-4 month period.

3. Allocation for testing and evaluation
5. Platform remains in operation

TOTAL EVA HRS 1500

Code: GDCD 2007

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Large Structures Technology

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation meeting NASA Hq., 14-15 Sept 1982

2. NASA Hq. Viewgraph, MT 79-2713(1), 6/11/79

3. Orbital Assembly and Maintenance Study, Final Report, August 1975 Martin Marietta Report MCR -75-319, Contract No. NASA -14319.

4. GDC Report CASD-ASP77-017, "SCAFEDS Final Report, 1 II, Study Results", 26 May 1978

Narrative:

Payload element objective, description, skill type, specimen considerations, and nominal length are based on Ref 1.

The EVA time estimate is based on Ref 2 using beam building concept, or Ref 3 using erection concept for shuttle delivered pre-fabricated structure.

All other data is derived. (The originator of the P/L element was contacted.)

The test structure size of 1000 by 200 by 5 meters is based on Ref 1. The structure design is based on SCAFEDS technology (Ref 4). The mass is scaled from SCAFEDS technology at 0.5 kg/m^2. The Beam Builders and associated assembly fixtures are not included in this mass estimate.

LARGE STRUCTURES TECHNOLOGY EXPERIMENTS

I. Mission Objective

To provide a technology base for the design and analysis of very large space structures having dimensions larger than are compatible with Space Shuttle experiments.

II. Mission Description

Assembly and testing of very large space structures will require utilization of the Space Station as a base for these activities. Maintaining a long lifetime stable platform for assembly and inertial structural characterization testing is important for the evolution of large structure technology. A large facility that can be used for assembly and environmental testing would be required on the Space Station. This facility would include data acquistion and analysis capabilities mechanical operations support and maintenance capabilities, and a supply of goods and tools to allow modifications to large structure designs while on-orbit. Complete dynamic testing capabilities will be required to determine mode shapes, inertial properties, damping/influence coefficients, and other design parameters necessary to characterize the stability and dynamics of very large space structures.

III. Benefit

Many future manned and unmanned missions will depend on assembly and testing of very large space structures enabling new design concepts for structures having kilometer dimensions.

IV. Justification

The long duration, low gravity, and stability characteristics of the Space Station will be an ideal base for the assembly and testing of very large space structures. The inevitability of the very large space structures as a basis for future space missions is certain.

V. Mission Requirements & Capabilities

A) Orbital Parameters - Low inclination for certain thermal shock experimental missions during solar eclipse. High inclination for long term thermal stabilization (no eclipses) during other experimental missions. High altitude to minimize drag perturbations on large structures.

B) Mass, volume, operational envelope is TBD. Mass of components requiring assembly (many thousands of kilograms) could necessitate multi-shuttle launchs. Volume requirements for materials could also require multiple launches. Operational envelope could be many kilometers in dimension requiring some kind of EVA/Teleoperator system.

C) Power - The power requirements would be in the many kilowatt range to allow the assembly and testing activities.

D) Thermal Control - No requirements identified

E) Attitude, Stabilization - A stable platform is necessary for assembly and some testing. Possible isolation from the Space Station perturbations may be necessary during structural dynamics testing. This may be accomplished using either a free-flyer concept or a tether.

F) Viewing - No requirements identified.

G) Environmental Constraints - Low g environment free from micro-g perturbations.

H) Data Management, Communications - A data acquisition and analysis facility would be required to gather and interpret the structural assembly and testing experiments in real time. A communications link would either be hard wired if the structure were attached to the Space Station (or on a tether), or an RF link would be necessary from a free flyer to the data facility on the Space Station.

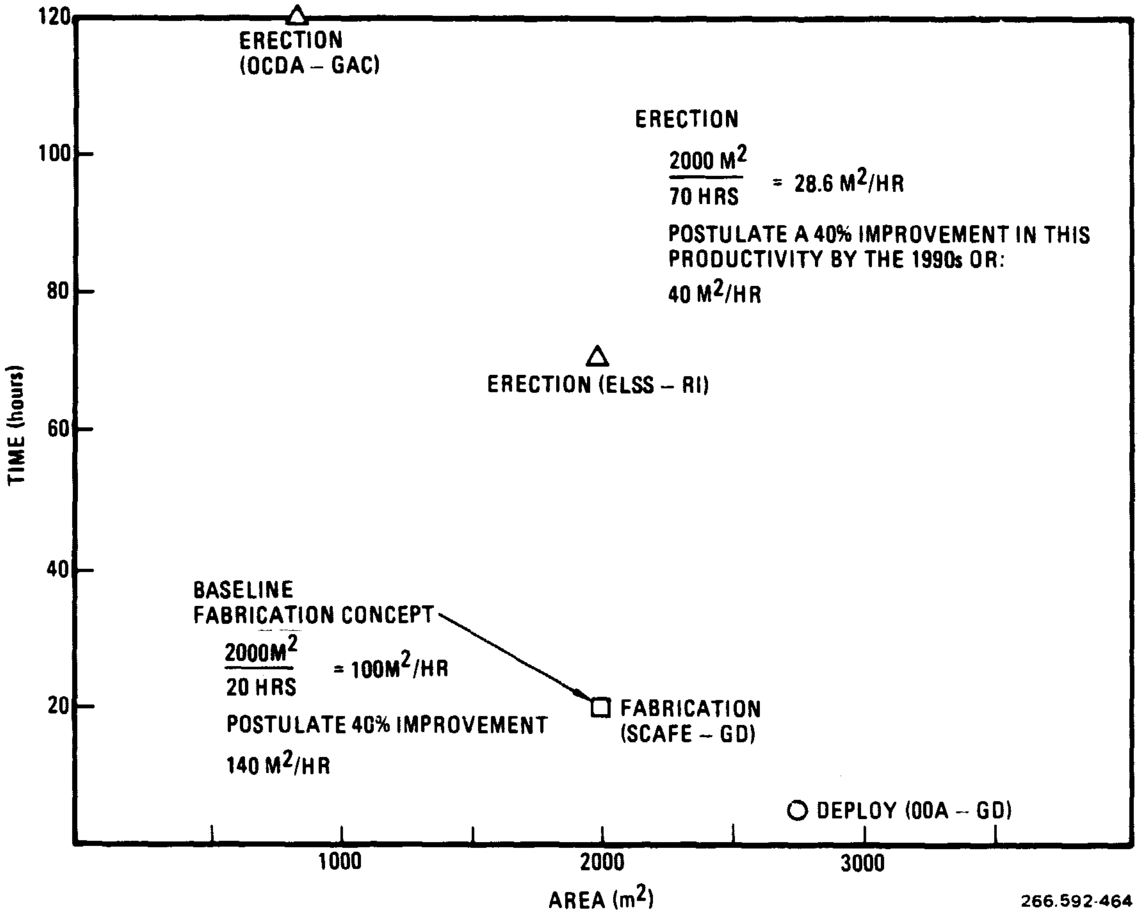
I) Crew Timeline - Payload specialists would be trained to assemble and test the large structures. Testing coordination between the on-board data facility and engineering teams on the ground would require detailed event timelines to assure the adequacy and completeness of the tests and iterations required.

J) Operations Schedule, Maintenance, Lifetime - TBD

VI. Space Station vs. Free Flyer

If the stability of the Space Station can be controlled precisely (e.g. TBD) enough, some testing might be possible while attached to the Station. Some testing will probably require isolation from the Station either using tether system or a free flyer concept.

Derived from Ref 2.



Productivity of Space Construction Techniques

Section 3.2

Discipline Energy Conversion

GDCD ID NO.	PAYLOAD ELEMENT NAME
2101	Low-Cost Modular Solar Panels
2102	Reserved
2103	Ion Effects on LEO Power Systems
2104	Large Solar Concentrator
2105	Solar Pumped Lasers
2106	Laser/Electric Energy Conversion
2107	Solar Sustained Plasmas
2108	Space Nuclear Reactor

PAYLOAD ELEMENT NAME
Low-Cost Modular Solar Panels

CODE G D C D 2 1 0 1

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1991
No. of flights 1
Duration of Flight, days 3650+

TYPE

- ☐ Science & Applications (non-commercial)
- ☒ Commercial
- ☐ Technology Development
- ☐ Operations

Type Number (see Table A) 11

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

OBJECTIVE To provide the technology development and demonstration of spacecraft solar panels that embody features that allow them to be low cost, but nearly as long-lasting and efficient as current panels. The solar panels would incorporate modular design features to allow easy replacement of malfunctioning sections. Array output voltage would be variable to test plasma effects.

DESCRIPTION This mission would provide testing and demonstration of the technology for design and manufacture of low cost solar panels. Their cost would be greatly reduced by the use of design features suitable for space, but with application of commercial standards used for the production of reliable earth-based solar panels. The Space Station makes possible the continuous, long-term test in parallel of several candidate solar panel and power system designs, in real conditions. It makes available the space vacuum, the orbital radiation environment and the thermal cycling of continuous, frequent orbital eclipses. The thermal cycling that solar panels must ensure and the plasma effects on high voltage arrays are among the most important and least understood causes of solar panel failure. This mission would allow us to understand the causes of these failures.

CODE G D C D 2 1 0 1

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☒ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec 10,000 Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec Pointing within 30 deg of sunline
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 2 1 0 1

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 5 W,m 1 H,m 0.5 Stowed

L,m 5 W,m 6 H,m 0.1 Deployed

Launch mass, kg 30

Consumables Types ______

Acceleration sensitivity, g min ______ max 0.1

CREW REQUIREMENTS

Crew Size 1

Task Assignment Monitor Specimen Condition

Skills (See Table B)

SKILL	1					
LEVEL	1					
Hrs/Day	0.1					

EVA ☒ YES ☐ NO Reason Mount, Replace Panels Hrs/EVA 120

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day 180 Man/Hrs Req. 6

Deliverables, kg 30 Returnables, kg 30

SPECIAL CONSIDERATIONS/See Instructions

Payload is self-powered. Accel level is for deployed configuration.

GDCD CODE 2101 ELEMENT NAME LOW-COST MODULAR SOLAR PANELS

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1991 INT. HRS ____ EVA HRS 6 EVA CREW 1

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.1 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL 180 DAYS TOTAL RECONFIGS. 19

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☐ NOT APPLICABLE EVA HRS PER RECONFIG. 6

   EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

   DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Initial placement of solar panels.
4. Replacement of panels at 6 mo. intervals.
3. Monitoring of panel performance.
5. Panels stay in place past year 2000.

TOTAL EVA HRS 120

Code: GDCD 2101

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Low Cost Modular Solar Panels

Reference Documents:

1. Technology Development Missions, NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982

Narrative:

Payload element objective, description and space station accommodations are from Ref 1. Size, weight, and pointing constraints are based on Ref 1.

All other data is derived. Payload element station supported operations are assumed to start as early as possible.

The solar panel size of 150 square meters was felt to be more than required and therefore was reduced to 30 square meters.

LARGE SPACE POWER SYSTEM TECHNOLOGY DEMONSTRATION

I. Mission Objective

Demonstrate the viability of multi-voltage operational scheme for large, high power space power system for space platforms.

II. Mission Description

A large solar array segment (sized up to 20 KW) will be assembled in modular form capable of generating power at various voltages from 200 to 1000 volts. This power will be brought into a collection system where it will be converted to AC (high frequency) for transmission to a power distributor system at least 50 m away. Transmission will be over several lines. Within the power distributor, the power will be conditioned for users (possibly 120v, 60 cycle).

III. Benefit

The experiment would be an enabling technology experiment, demonstrating the capability of building modularized space power systems to hundreds of kilowatts for operation in the space environment.

IV. Justification

Future space platform missions are projected to require 100 KW and larger power systems. At these high power levels, the operating voltages for the power generators must be increased to minimize harness losses. Operations at elevated voltages results in possible detrimental interactions with the space plasma environment. Hence, a compromise between the operating voltage required to minimize harness losses and voltages to minimize environment losses must be reached. Such a compromise is the proposed D.C. generation, A.C. transmission concept. In this system, power is generated in modularized solar array systems operating at a voltage compatible with environmental interactions, collected and converted to A.C. for transmission over the large distances to the electrical load distribution system.

The proposed experiment would be a verification of design concepts enabling the construction of larger systems. All of the elements of this space power system would be incorporated. The operation in the space plasma environment over extended periods of time would demonstrate the viability of the system and the understanding of plasma interaction concepts. Such an experiment could not be run from the Shuttle due to the system size and length of time required to justify extension to multiyear operations.

Code: GDCD 2101

PAYLOAD ELEMENT SYNTHESIS

V. Mission Requirements & Capabilities

A) Orbital Parameters - Operation in equatorial-like environments at altitudes of 300 to 400km with arbitrary inclination. (Space platform altitudes)

B) Mass, volume, operational envelope - The proposed experiment includes an approximately 15kw solar array divided into 3 circuits. Each of the 5KW blocks of cells is modularized so that the operating voltage can be controlled. From the power generator 3 transmission lines (50m long) run to the power distributor. The DC to AC conversion system will be located at the generator end of the system. Low frequency, A.C. power would be available at the distributor end for use of the space platform.

The mass has not been estimated as yet. The area of the array is about 150 square meters. It is proposed that this system function in sunlight for at least 6 months to complete the interaction evaluation. This includes the orbital eclipse shut-downs.

C) Power - Experiment will provide own power.

D) Thermal control - Self-contained thermal control subsystem.

E) Attitude, Stabilization - Power generator must be sunlit and held in nominal normal solar incidence on solar array.

F) Viewing - No shadowing of array by space structure allowed.

G) Environmental Constraints - System must function in space environment.

H) Data Management, Communications - Output parameters of system will be monitored. All measurements involving high voltage will be conditioned to be compatible with existing command and data systems.

I) Crew Timeline - Not applicable

J) Operating Schedule, Maintenance, Lifetime - It is desired to turn on this system and leave on for a minimum of 6 months. Data will be collected and analyzed. Operational mode changes will be commanded in as appropriate to obtain desired information. (This could be done by automated sequences). There should be no maintenance required.

PAYLOAD ELEMENT NAME
Ion Effects on LEO Power Systems

CODE G D C D 2 1 0 3

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 1992
No. of flights 1
Duration of Flight, days 365

OBJECTIVE
To obtain essential knowledge on power systems operating in an ion thruster generated plasma plume which is needed for design and development of advanced photovoltaic space power systems with high power and high voltage.

TYPE
☐ Science & Applications (non-commercial)
☐ Commercial
☒ Technology Development
☐ Operations

Type Number (see Table A) 11

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 9

DESCRIPTION Small prototypes of photovoltaic space power systems will be operated in the vicinity of an ion thruster in order to gain experimental data. These data will yield basic knowledge about the physical processes and permit verification of analytical models. The effects of both environment and ion engine generated plasma environment will be determined. Power losses, array degradation and electromagnetic interference are of major concern and must be carefully controlled. Data will be obtained for a variety of thruster propellants and will be useful for array type, size and voltage scaling.
The power generation solar arrays will be analyzed and tested including the effect of modifications incorporating mitigation techniques such as insulating and biasing. Operating constraints such as configuration and spacing from thrusters must be determined. Thrusters would be operated intermittently.

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CODE
GDCD2103

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☒ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec 7200 Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) No shadowing of array by space structure allowed.

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

ORIGINAL PAGE IS
OF POOR QUALITY

CODE GDCD2103

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 5 W,m 1 H,m 0.5 Stowed

L,m 5 W,m 6 H,m 0.1 Deployed

Launch mass, kg 150

Consumables Types Ion Thruster

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1

Task Assignment Evaluation Performance Degradation

Skills (See Table B)

SKILL	1					
LEVEL	2					
Hrs/Day	0.1					

EVA ☒ YES ☐ NO Reason Assembly/Config. Changes Hrs/EVA 20

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day 180 Man/Hrs Req. 5

Deliverables, kg 70 Returnables, kg 70

SPECIAL CONSIDERATIONS/See Instructions During normal operation ion thruster must be pointed opposite to the direction of travel. The power system must operate in the undisturbed flow of natural space plasma and not in the wake of Space Station. operation during worst case of the natural plasma (e.g., solar activity) is desired. The payload should be isolated from the main power system. Weight includes 30 square meter solar panels plus weight of 2 ion propulsion units. Estimated weight of 35 Kg each, including engine and tankage.

GDCD CODE 2103 ELEMENT NAME ION EFFECTS ON LEO POWER SYSTEM

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1992 INT. HRS ____ EVA HRS 5 EVA CREW 1

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.1 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 120 DAYS TOTAL RECONFIGS. 2

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☐ NOT APPLICABLE EVA HRS PER RECONFIG. 5

EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

DATE(S) 1993 INT. HRS. ____ EVA HRS 5 EVA CREW 1

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Attach ION engine
3. Monitoring and evaluation of performance
4. Replace ION engine/array - 2 trips
5. Remove ION engine

TOTAL EVA HRS 20

Code: GDCD 2103

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: ION Effects on LEO Power Systems

Reference Documents:

1. Technology Development Missions, NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982

2. Radio-Frequency ION Thruster Assembly For Orbit Control of Geostationary Satellites, MBB.

Narrative:

The payload element objective description and altitude are from Ref 1.

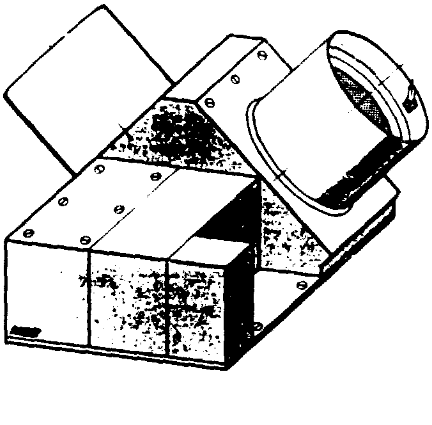
The experiment duration from Ref 1 was extended to 1 year to permit a change in the ION engine package to evaluate effects of a different thurster propellant.

All other data is derived. Weight is estimated for solar array plus 2 ION thruster units.

The following characteristics and sketch are extracted from Ref 2:

"Electric propulsion system for operational applications. This system includes two RIT-10 thrusters and all components for engine and neutralizer operation and control. The thrusters are inclined at 45 degrees to performing both N/S and E/W orbit control.

Compared with RITA-1, RITA-2 is an improved simplified system, with reduced telemetry- and telecommand interfaces by a complete automatic operation and control by microprocessor. Two units are required per satellite to be mounted on the east and west side panels of the spacecraft."



Nominal thrust per thruster	10 mN
Operating range	5–10 mN
Specific impulse	31 000 Ns/kg
Mass of 1 RITA-2 (dry)	25 kg
Propellant mass (max.)	10 kg
Power input per thruster	350 W

One or two thrusters can be operated.

266.592-465

ION THRUSTER EFFECTS ON LEO POWER SYSTEMS

I. Mission Objectives

To obtain essential knowledge on power systems operating in an ion thruster generated plasma plume which is needed for design and development of advanced photovoltaic space power systems with high power and high voltage.

II. Mission Description

Prototypes of advanced photovoltaic space power systems must be operated in the vicinity of an ion thruster in order to gain essential experimental data. This data will be analyzed to yield basic knowledge about the physical processes and ultimately verification of analytical models and practical power system designs.

The effects of both natural plasma environment and ion engine generated plasma environment must be determined. Power losses, array degradation and electromagnetic interference are of major concern and must be carefully controlled.Data must be obtained for a variety of thruster propellants and useful for array type, size and voltage scaling.

Both plasma and concentrator solar arrays must be analyzed and tested including the effect of modifications incorporating mitigation techniques such as insulating and biasing. Operating constraints such as configuration and spacing from thrusters must be determined.

The effects to be studied are:

- o Pinhole effects at positive potentials, secondary emission
- o Sheath processes, non-linear expansion with potentials
- o Magnetic field constraints on particle trajectories
- o High electric field emission of electrons
- o Ultraviolet radiation effects - photoemission
- o Ram and wake effects due to spacecraft velocity
- o Arc and corona breakdown (avalanche) effects

III. Benefits

High power high voltage missions of the future can not be enabled

without knowledge of physical processes involving the interactions of the electrical power system and the natural and ion engine generated plasma environment. Protective design techniques will be analyzed, designed, implemented, tested and developed assuring a high reliability final design approach that will then be demonstrated.

IV. Justification

The Space Station facility is required for this mission because of: the large separation distances required between the ion source and the power system, the operation of large scale, high voltage, prototype solar arrays and, the high vacuum requirement.

V. Mission Requirements and Capabilities

A) Operation in equatorial-like environments at altitudes of 300 to 400km with arbitrary inclination. (Space platform altitudes)

B) Mass, Volume, Operational Envelope - The mass has not been estimated as yet. The area of the array is about 150 square meters. It is proposed that this system function is sunlight for at least 6 months to complete the interaction evaluation. This includes the orbital eclipse shut-downs.

C) Power - Experiment will provide own power including power to the ion thruster.

D) Thermal Control - Self-contained thermal control subsystem.

E) Attitude, Stabilization - Power generator must be sunlit and held in nominal normal solar incidence on solar array. During normal operation, ion thruster shall be pointed opposite to the direction of travel.

F) Viewing - No shadowing of array by space structure allowed.

G) Environmental Constraints - The power system must operate in the undisturbed flow of natural space plasma and not in the wake of the space station. Operation during worst case of the natural plasma (solar activity, etc.) is desired.

H) Data Management, Communications - Output parameter of system will be monitored. All measurements involving high voltage will be conditioned to be compativle with existing command and data systems.

I) Crew Timeline - Not applicable

J) Operations Schedule, Maintenance, Lifetime - It is desired to turn on this sytems and leave on for a minimum of 6 months. Data will be collected and analyzed. Operational mode changes will be commanded in as appropriate to obtain desired information. (This could be done by automated sequences). There should be no maintenance required.

PAYLOAD ELEMENT NAME
Large Solar Concentrator

CODE G D C D 2 1 0 4

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1995
No. of flights 1
Duration of Flight, days 365

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 11

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 9

OBJECTIVE To develop and deploy a large permanent mirror facility to capture and concentrate AM-0 solar radiation. To accurately establish optical characteristics of this facility through systematic measurements, and to assess the long-term stability of the optical characteristics of the mirror.

DESCRIPTION

The mission will provide the facility necessary for other Advanced Energetics missions. It will require development and deployment of a large stable concentrating reflector, and will permit assessment of the stability of 1) reflecting optical coatings, and 2) mechanisms for producing and holding optical quality reflector shapes in the space environment.

CODE G D C D 2 1 0 4

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance ± ____
Inclination, deg Any ____ Tolerance ± ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☒ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec < 900 Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) No shadowing of mirror by space structure allowed

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 2 1 0 4

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed
L,m 10 W,m 10 H,m 10 Deployed

Launch mass, kg 5000

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1

Skills (See Table B)

Task Assignment: Assess Optical Characteristics

SKILL	1					
LEVEL	2					
Hrs/Day	0.2					

EVA ☒ YES ☐ NO Reason Deploy/Optical Measurement Hrs/EVA 48

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions A significant effort will be required to deploy a large high-quality reflector 2-man EVA is is assumed for deployment. More effort will be needed to characterize its operation. Thus, it requires man in the set-up loop. Later it will require man to install, check out, operate, and repair advanced experiments. This facility requires a manned spacecraft with a mission life that is very long compared to the set-up and mapping times for the mirror. No Space Station power is required. No thermal control is required.

GOCO CODE 2104 ELEMENT NAME LARGE SOLAR CONCENTRATOR

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1995 INT. HRS ____ EVA HRS 24 EVA CREW 2

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

____ HRS PER DAY (INTERNAL)

0.6 HRS PER DAY (EVA)

☒ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. EVA required to set up reflector. 2 men, 2=6 hour days.
3. EVA required for optical measurements .06 hour per day for year=24 hour total
5. Concentrator left in place for new experiments.

TOTAL EVA HRS 48

Code: GDCD 2104

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Large Solar Concentrator

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientaztion meeting, NASA Hq., 14-15 Sept 1982

Narrative:

Payload element objective description, and EVA reasons are from Ref 1.

All other data is derived.

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title: Advanced Energetics Research-I **Langley Contact:** E. J. Conway

Experiment Title: Deployment and Testing of Large Solar Concentrator

Mission Objectives: To develop and deploy a large permanent mirror facility to capture and concentrate AM-0 solar radiation. To accurately establish the optical characteristics of this facility through systematic measurements, and to assess the long-term stability of the optical characteristics of the mirror.

Mission Description: The mission will provide the facility necessary for other Advanced Energetics missions. It will require development and deployment of a large stable concentrating reflector, and will permit assessment of the stability of 1) reflecting optical coatings, and 2) mechanisms for producing and holding optical quality reflector shapes in the space environment.

Benefit: This facility would be required for other experiments and would be a test item itself for optical coatings and shape.

Justification: Currently, space solar energy is only used as a power source with large flat plates of photovoltaic cells. Other conversion schemes for solar energy (such as solar-pumped lasers, solar-sustained plasmas and solar thermal engines) have been conceived, but most require solar concentration. This mirror would provide the well-characterized, high-quality concentrator in the AM-0 environment necessary to properly develop and test advanced energy concepts.

Mission Requirements and Capability: The facility will require pointing and tracking to be useful. EVA will be required for deployment and intensity mapping.

Space Station vs. Free Flyer: A significant effort will be required to deploy a large high-quality reflector. More effort will be needed to characterize its operation. Thus, it requires man in the set-up loop. Later it will require man to install, checkout, operate, and repair advanced experiments. This facility requires a manned spacecraft with a mission life that is very long compared to the set-up and mapping time for the mirror.

PAYLOAD ELEMENT NAME
Solar-Pumped Lasers

CODE GDCD 2105

CONTACT
Name / Address: W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1996
No. of flights 1
Duration of Flight, days 270

OBJECTIVE

a. To demonstrate, calibrate and test the operation of a solar-pumped laser using the AM-0 solar spectrum.
b. To provide a realistic comparison of several solar laser types.

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 11

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 9

DESCRIPTION This mission will demonstrate for the first time solar-pumped lasing using the full solar spectrum (rather than a simulated spectrum). It will provide for the accurate measurement of solar laser efficiency which is spectrum and temperature-dependent and will provide for long-term operation to assess lasant stability and lasant reconstitution efficiency. The experiment will utilize the large solar concentrator deployed as payload GDCD 2104.

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CODE GDCD2105

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg Any Tolerance + -
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☒ Solar ☐ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec <900 Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) No shadowing of mirror by space structure allowed

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

CODE GDCD 2105

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m 10 W,m 10 H,m 10 Deployed

Launch mass, kg 200

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2 Task Assignment Evaluate Laser Performance

Skills (See Table B)

SKILL	1					
LEVEL	2					
Hrs/Day	0.2					

EVA ☒ YES ☐ NO Reason Placement/Reconfiguration Hrs/EVA 18

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day 90 Man/Hrs Req. 6

Deliverables, kg 10 Returnables, kg 10

SPECIAL CONSIDERATIONS/See Instructions The mission will require accurately repeatable pointing of the concentrator toward the sun and away from it. Placement of the laser in the calibrated focal region of the concentrator and attachment to thermal radiators will require EVA. Laser power and temperature measurements may also require human help. The human involvement required in installing the laser and making measurements may also require a manned spacecraft. Long-term operation (on the order of weeks or months) requires a long-duration, manned spacecraft. No Space Station power is required. No thermal control is required. Weight for laser only. Uses GDCD 2104 collector.

GOCD CODE 2105 ELEMENT NAME SOLAR PUMPED LASERS

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1996 INT. HRS ____ EVA HRS 6 EVA CREW 2

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.2 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 90 DAYS TOTAL RECONFIGS. 2

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☐ NOT APPLICABLE EVA HRS PER RECONFIG. 6

EVA CREW SIZE 2

5. DEACTIVATION/REMOVAL

DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. EVA required to install lasers.
3. Control and monitoring of laser performance.
4. 2 trips required to changeout lasers
5. Left in place for new experiments. (-2106)

TOTAL EVA HRS 18

Code: GDCD 2105

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Solar-Pumped Lasers

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982

Narrative:

The payload element objective, description, EVA reasons, and relation to earlier mission objectives are from Ref 1. The earlier mission is defined by GDCD 2104. Since this payload element uses laser elements of GDCD 2104, the schedule is sequenced.

All other data is derived.

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title: Advanced Energetics Research - II **Langley Contact:** E. J. Conway

Experiment Title: Test Solar-Pumped Lasers

Mission Objectives: To demonstrate, calibrate, and test the operation of a solar-pumped laser using the AM-0 solar spectrum and to use a large, high-quality optical concentrator deployed and characterized as an earlier mission objective. To provide a realistic comparison of several solar laser types.

Mission Description: The mission will demonstrate for the first time solar-pumped lasing using the full solar spectrum (rather than a simulated spectrum). It will provide for the accurate measurement of solar laser efficiency which is spectrum and temperature-dependent and will provide for long-term operation to assess lasant stability and lasant reconstitution efficiency.

Benefit: Solar-pumped lasers offer potentially revolutionary advances in space power and propulsion. This will be their first severe space test. Solar-pumped lasers offer low-maintenance, low-cost solar conversion. Long-term tests will assess the claim of low maintenence. Several lasants can be compared.

Justification: Lasers offer very important cost benefits for space propulsion and may be economical for space electric power, communications, and space processing. Trial and development of this technology is crucial to establishing its feasibility and reliability.

Mission Requirements and Capability: The mission will require accurately repeatable pointing of the concentrator toward the sun and away from it. Placement of the laser in the calibrated focal region of the concentrator and attachment to thermal radiators will require EVA. Laser power and temperature measurements may also require human help.

Space Station vs. Free Flyer: The human involvement required in installing the laser and making measurements and lasant changes requires a manned spacecraft. Long-term operation (on the order of weeks or months) requires a long-duration, manned spacecraft. Also, if the high-quality concentrator is on the space station, then the laser test must also be on the space station.

PAYLOAD ELEMENT NAME
Laser/Electric Energy Conversion

CODE GDCD2106

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 1996
No. of flights 1
Duration of Flight, days 450

TYPE
☐ Science & Applications (non-commercial)
☐ Commercial
☒ Technology Development
☐ Operations

Type Number (see Table A) 11

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 4

OBJECTIVE

To characterize and compare for space operation the performance of laser-to-electric power converters, and to demonstrate short-range laser-power transmission in space.

DESCRIPTION

Using a solar-pumped laser deployed and characterized as payload GDCD 2105 transmission over the longest spacecraft dimension will be performed and the intensity pattern at the converter site measured. An assessment of converter performance, efficiency, stability for long-term operation and resistance to environmental interference or degradation will be performed for a set of converters.

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CODE G D C D 2 1 0 6

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☒ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec <900 Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) No shadowing of mirror by space structure allowed

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

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CODE G D C D 2 1 0 6

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m 10 W,m 10 H,m 10 Deployed

Launch mass, kg 500

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1 Task Assignment Evaluate Laser Power Transmission

Skills (See Table B)

SKILL	1					
LEVEL	2					
Hrs/Day	0.2					

EVA ☒ YES ☐ NO Reason Setup Power/Reconfiguration Hrs/EVA 18

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day 150 Man/Hrs Req. 6

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

The major requirements will be periods of manned interaction, long-term constant power operation of the laser and recording of data for post-flight study. The program requires man tended operation and use of calibrated and operational facilities already developed and in place on the space station from earlier experiments. No Space Station power is required. No thermal control is required. Weight is for boiler, turbo machinery, alternator only.

GDCD CODE 2106 ELEMENT NAME LASER/ELECTRIC ENERGY CONVERSION

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1996 INT. HRS ____ EVA HRS 6 EVA CREW 2

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.2 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL 150 DAYS TOTAL RECONFIGS. 2

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG ____

   ☐ NOT APPLICABLE EVA HRS PER RECONFIG. 6

   EVA CREW SIZE 2

5. DEACTIVATION/REMOVAL

   DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. EVA required to install power converter (uses laser from 2105)
3. Control and monitoring of converter performance
4. 2 trips required to changeout lasers
5. Most of apparatus required for new experiment.

TOTAL EVA HRS 18

Code: GDCD 2106

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Laser Electrical Energy Conversion

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982

Narrative:

The payload element objective, description, use of developed facility/equipment and special considerations are from Ref 1. The earlier mission is defined by GDCD 2105. Since the payload element uses elements of GDCD 2105, the schedule is sequenced.

All other data is derived.

Code: GDCD 2106

PAYLOAD ELEMENT SYNTHESIS

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title: Advanced Energetics Research - III **Langley Contact:** E. J. Conway

Experiment Title: Laser-to-Electric Energy Conversion

Mission Objectives: To characterize and compare for space operation the performance of laser-to-electric power converters, and to demonstrate short-range laser-power transmission in space.

Mission Description: Using a solar-pumped laser deployed and characterized under an earlier mission objective, transmission over the longest spacecraft dimension will be performed and the intensity pattern at the convertor site measured. An assessment of convertor performance, efficiency, stability for long-term operation and resistance to environmental interference or degradation will be performed for a set of convertors.

Benefit: By flight time, terrestrial R & D will have developed several useful laser-to-electric power conversion devices. Their efficiency, stability and reliability will require extensive space testing. Their environmental interaction and the maturity of the technologies will be assessed and improved as required.

Justification: The high cost and limited quantity of electric power in space has been identified as a limiting factor to expanding space activities. A change of function, from each spacecraft generating its own power to specialized central power stations producing and beaming power, could provide much more available power at reduced costs. R & D to assess these possibilities will require substantial space testing.

Mission Requirements and Capability: The major requirements will be periods of manned interaction, long-term constant power operation of the laser and recording of data for post-flight study.

Space Station vs. Free Flyer: This program requires man tended operation and use of calibrated and operational facilities already developed and in place on the space station from earlier experiments.

PAYLOAD ELEMENT NAME
Solar-Sustained Plasma

CODE GDCD 2107

CONTACT

Name W. Hardy/J. Peterson MZ 21-9530

Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1997
No. of flights 1
Duration of Flight, days 450

OBJECTIVE

To demonstrate, contain, and characterize solar-sustained plasmas and to operate, and refine MHD electric power generation in space and plasma thruster performance.

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 11

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

DESCRIPTION

Concentrated sunlight will excite a plasma. Characteristics of the plasma and its containment system will be assessed in terms of theoretical performance and prior terrestrial tests. After suitable control and understanding have been achieved, the plasma will be used in MHD electrical generating systems to identify their space feasibility and operating constraints. The plasma will also be assessed as the exhaust medium for thermal plasma thrusters and for MPD thrusters. The mission will utilize the large solar concentrator deployed. Ref. payload GDCD 2104.

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CODE G D C D 2 1 0 7

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☒ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec <900 Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 2 1 0 7

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ____ max ____
non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ____ W,m ____ H,m ____ Stowed
L,m 10 W,m 10 H,m 10 Deployed

Launch mass, kg 2000

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 2 Task Assignment Assess Plasma Performance

Skills (See Table B)

SKILL	1					
LEVEL	3					
Hrs/Day	0.2					

EVA ☒ YES ☐ NO Reason Assembly/Reconfig/Remove Hrs/EVA 30

SERVICING/MAINTENANCE

SERVICE: Interval, days ____ Consumables, kg ____
Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day 225 Man/Hrs Req. 6
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Operation and testing of these devices will require diagnostic equipment both for the plasmas and for device operation, as well as the large solar concentrator and the high-temperature thermal radiator. Control by onboard scientists will be required. No Space Station power is required. Weight is for MHD generator, magnets only. Disassembly required. Last use of equipment.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 2107 ELEMENT NAME SOLAR-SUSTAINED PLASMAS

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1997 INT. HRS ____ EVA HRS 12 EVA CREW 2

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.2 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL 225 DAYS TOTAL RECONFIGS. 1

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☐ NOT APPLICABLE EVA HRS PER RECONFIG. 6

   EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

   DATE(S) 1998 INT. HRS. ____ EVA HRS 12 EVA CREW 2

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. EVA (2 days, 6 hrs each) required to set up plasma device (uses 2104 concentrator
3. Measurement and evaluation of performance
4. 1 reconfiguration (6 hr) to changeout thrusters
5. Disassemble all exp. equipment and prepare for earth return

TOTAL EVA HRS 30

Code: GDCD 2107

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Solar-Sustained Plasmas

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982

Narrative:

The payload element objective, description, use of developed facility/equipment, special considerations, and skill level, are from Ref 1. The earlier mission is defined by GDCD 2104. Since the payload element uses elements of GDCD 2104 the schedule is sequenced.

All other data is derived.

Code: GDCD 2107

PAYLOAD ELEMENT SYNTHESIS

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title: Advanced Energetics Research - V **Langley Contact:** E. J. Conway

Experiment Title: Solar-Sustained Plasmas

Mission Objectives: To demonstrate, contain, and characterize solar-sustained plasmas and to operate, assess, and refine MHD electric power generation in space and plasma thruster performance.

Mission Description: Concentrated sunlight will excite a plasma. Characteristics of the plasma and its containment system will be assessed in terms of theoretical performance and prior terrestrial tests. After suitable control and understanding have been achieved, the plasma will be used in MHD electrical generating systems to identify their space feasibility and operating constraints. The plasma will also be assessed as the exhaust medium for thermal plasma thrusters and for MPD thrusters.

Benefit: The direct use of solar radiation to produce plasmas will enable smaller, simpler space power and propulsion systems. Plasma devices which operate at high temperature require only small radiators to reject waste heat and thus offer important system and economic advantages for future applications.

Justification: Large amounts of free but low density energy exist in space in the form of sunlight. Capture, concentration to useful levels, and control of this energy is presently accomplished with photovoltaic cells and storage batteries. Optical concentration of sunlight and the production of high-temperature and ionized gases could provide an attractive option for the future, especially for near-earth space processing requirements.

Mission Requirements and Capability: Operation and testing of these devices will require a large, high-quality solar concentrator (developed and put into operation during an earlier mission), a high-temperature thermal radiator, and diagnostic equipment both for the plasmas and for device operation. Control by on-board scientist will be required.

Space Station vs. Free Flyer: Space station will be required for this program since the research and testing require human interaction, long term operation, auxiliary equipment and electric power and a large high-quality mirror (which was developed under an earlier space station mission).

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PAYLOAD ELEMENT NAME
Space Nuclear Reactor

CODE G D C D 2 1 0 8

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1997
No. of flights 1
Duration of Flight, days 2560

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 11

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 9

OBJECTIVE

To evaluate the performance, reliability and life of a nuclear reactor of 100 kilowatts electrical power generating capability in the space environment.

DESCRIPTION

A 100KW nuclear reactor (7% efficiency, 800 - 900°C) will be deployed at the Space Station and connected to the station power distribution system. The Space Station power requirements will serve as the electrical load for the reactor which will be deisgned for long term operation in space. Source: Los Alamos National Labs. Joint DoD/DOE/NASA Project.

CODE G D C D 2 1 0 8

ORBIT CHARACTERISTICS

Apogee, km LEO ______ Perigee, km LEO ______ Tolerance + ______ -

Inclination, deg Any ______ Tolerance + ______ -

Nodal Angle, deg ______ Ephemeris Accuracy, m ______

Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ______

Pointing accuracy, arc sec ______ Field of view, deg ______

Pointing Stability (Jitter) arc sec/sec ______

Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	______	______
Standby	______	______
Peak	______	______

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☒ Realtime ☒ Offline ☐ Other ______

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______

☐ On-Board Data Processing Required

Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______

Film (Amount) ______ Voice (Hrs/Day) ______

Live TV (Hrs/Day) ______ Other ______

On-Board Storage (MBIT) ______

Data Dump Frequency (Per Orbit) ______

Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

CODE G D C D 2 1 0 8

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 7 W,m 4.5 H,m 4.5 Stowed
L,m 100 W,m 4 H,m 4 Deployed

Launch mass, kg ______
Consumables Types ______
Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1 Task Assignment Monitor Performance Data

Skills (See Table B)

SKILL	1					
LEVEL	1					
Hrs/Day	0.1					

EVA ☒ YES ☐ NO Reason On-Orbit Deployment Hrs/EVA 20

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

No thermal control required. No Space Station power required. Reactor and radiator support boom approximately 90 meters long stowed, for Shuttle delivery, around circumference of 80 sq. meter radiator. Radiation level at Space Station 10^{12} nvt neutrons, 10^{6} rads gamma.

GDCD CODE 2108 ELEMENT NAME SPACE NUCLEAR REACTOR

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER* ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1997 INT. HRS ____ EVA HRS 20 EVA CREW 2

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.1 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

*Free Flyer accommodation is an alternate mode, and if used will require re-evaluation of all requirements.

1. EVA required for deployment of reactor and boom, and for attachment to station.
2. Monitoring and evaluation of performance.
5. Reactor operation after year 2000.

TOTAL EVA HRS 20

Code: GDCD 2108

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Space Nuclear Reactor

Reference Documents:

1. Los Alamos National Labs Briefing, Oct 1982

2. "Science" Vol 218, 17 Dec 1982 pp 1199-1201

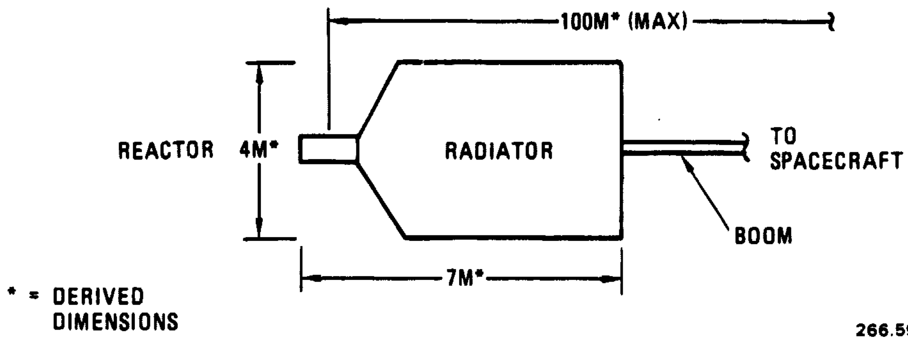
Narrative:

Ref 1 describes a nuclear thermoelectric power source for use in space. The unit is 10-100 KW with 100 KW as a design point (upper range of 200 KW). It uses heat pipes with no rotating machinery. The control rods (which rotate) are the only moving parts. It is intended for unmanned applications, but with appropriate spacing/shielding would be suitable for a manned station. The following are some technical parameters:

Technology is in development. A major advancement is required for the heat pipes in materials and for operating temperatures. LANL anticipates 8-9 years to deployment; NASA estimates 14-15 years. A Space Station would shorten development time by taking advantage of the long term presence in the space environment, for example, in heat tube technology.

Mission duration 7 years is from Ref 2, p 1200.

WEIGHT	20-30 KG/KW ELECTRICAL
POWER LEVEL	100 KW
EFFICIENCY	7%
TEMPERATURE	800-900 DEG K
RADIATOR AREA	80 M^2
REACTOR	55 CM DIA BY 55 CM LONG
DEPLOYED DISTANCE	25-100M
RADIATION (AT SPACECRAFT, ASSUMING SOME SHIELDING)	10^{12} NVT NEUTRONS 10^6 RADS GAMMA



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Section 3.3

Discipline Computer Science & Electronics

GDCD ID NO.	PAYLOAD ELEMENT NAME
2201	Attitude Control - System Identification Experiment
2202	Attitude Control - Adaptive Control Experiment
2203	Attitude Control - Distributed Control Experiment
2204	Advanced Adaptive Control Technology Demonstration

PAYLOAD ELEMENT NAME
Attitude Control, System Identification

CODE GDCD2201

CONTACT

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Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1994
No. of flights 1
Duration of Flight, days 365

OBJECTIVE

To validate sensing strategy/mechanization, identification algorithms and integrated flight control dynamics reconstruction subsystem; establishing off-line and real-time knowledge of flexible Space Station and payload dynamics.

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 12

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 7

DESCRIPTION

The experiment will consist of distributed excitation and sensing of structure and payloads. Sensor outputs will be recorded for off-line system identification or processed sequentially for on-board identification. A large structure will be constructed to facilitate characterizing dynamics and control parameters.

CODE G D C D 2 2 0 1

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg Any Tolerance + -
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec ______ Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☒ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	1000	
Standby	0	
Peak	1000	

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 1 Downlink Frequency (MHZ) ______

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CODE G D C D 2 2 0 1

THERMAL

☐ Active ☐ Passive

Temperature, deg C — operational min ____ max ____
non-operational min ____ max ____

Heat Rejection, w — operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ____ W,m ____ H,m ____ Stowed

L,m 100 W,m ____ H,m ____ Deployed

Launch mass, kg 100

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 2

Task Assignment: Characterize Structure Dynamics

Skills (See Table B)

SKILL	1	5				
LEVEL	2	2				
Hrs/Day	0.1	0.1				

EVA ☒ YES ☐ NO Reason Assembly/Reconfig/ Remove Hrs/EVA 20

SERVICING/MAINTENANCE

SERVICE: Interval, days ____ Consumables, kg ____
Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day 90 Man/Hrs Req. 24
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Exper requires a stable environ to assure accurate measurements which would not be affected by Space Station. Low-g environ free from vibration perturbations. Random crew motion & on-board equip vibration must be minimized to achieve clean identification environ. A data acquisition facil would be necessary to record & analyze data. Uses struct from GDCD 2005. Weight is for sensors, controls, wiring only. If struct perturbations caused by activities on the SS can be minimized, the exper structure can be attached. No viewing/pointing req'ments. Thermal control not req.

GDCD CODE 2201 ELEMENT NAME ATT CNTRL-SYSTEM IDENT EXPERMT

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1994 INT. HRS 6 EVA HRS 6 EVA CREW 1

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.2 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL 90 DAYS TOTAL RECONFIGS. 3

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 4

   ☐ NOT APPLICABLE EVA HRS PER RECONFIG. 4

   EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

   DATE(S) 1995 INT. HRS. 2 EVA HRS 2 EVA CREW 1

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Reconfig struct from GDCD 2005 for this experiment
3. Characterize structural dynamics for multiple variations
5. Remove experiment peculiar equipment not needed later

TOTAL EVA HRS 20

Code: GDCD 2201

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Attitude Control - System Identification Experiment

Reference Document:

1. Technology Development Missions, Space Stations NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982

Narrative:

The payload element objective, description, special considerations, power and skill level are from Ref 1. Control of crew perturbations is assumed for the attached mode.

All other data is derived. This payload element uses the structure provided by GCDC 2005 Dynamics of Flimsy Structures.

ATTITUDE CONTROL - SYSTEM IDENTIFICATION EXPERIMENT

I. Mission Objectives

To validate sensing strategy/mechanization, identification algorithms and integrated flight control dynamics reconstruction subsystem; establishing off-line and real-time knowledge of flexible Space Station and payload dynamics.

II. Mission Description

The experiment will consist of distributed excitation and sensing of structure and payloads. Sensor outputs will be recorded for off-line system identification or processed sequentially for on-board identification.

III. Benefit

These experiments will establish in-flight control performance of large flexible structures. In addition, they will determine vehicle intertia/CG and mode shapes and frequencies which will assist future design concepts.

IV. Justification

Accurate control of large flexible structures requires a knowledge of the dynamic characteristics. These experiments are necessary to establish these charactistics which lead to advance control system concepts for the large structures.

V. Mission Requirements & Capabilities

A) Orbital Parameters - High enough altitude to prevent drag effects on structure.

B) Mass, volume, operational envelope - Transporation of large number of elements (TBD) to construct an adequately sized structure to characterize large structure dynamics and control.

C) Power - The power requirements would be on the order of a kilowatt for the excitation and data acquisition systems.

D) Thermal Control - no requirement

E) Attitude, Stabilization - The experiments must be done in a stable environment to assure accurate measurements which would not be affected by Space Station.

F) Viewing - No requirements

G) Environmental Constraints - low g environment from vibration perturbations.

H) Data Management, Communications - A data acquisition facility would be necessary to record and analyze the data. Communications would be by hard wire link if attached to the Station or RF transmission to the Space Station if on a free flyer.

I) Crew Timeline - Random crew motion and on-board equipment vibration must be minimized to achieve clean identification environment. Payload specialists would be needed for assembly and configuration changes.

J) Operations Schedule, Maintenance, Lifetime-TBD

VI. Space Station vs. Free Flyer

If the structural perturbations caused by activities on the Space Station can be minimized, then the experimental structure can be attached. Otherwise, a tethered or free flyer configuration must be used.

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PAYLOAD ELEMENT NAME
Attitude Control, Adaptive Contr.

CODE G D C D 2 2 0 2

CONTACT
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Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1994
No. of flights 1
Duration of Flight, days 365

TYPE
- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 12

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 7

OBJECTIVE

To validate performance and stability improvement sensing strategies and mechanization, control gain update subroutines and reconfiguration schemes, and adaptive control algorithms.

DESCRIPTION

This experiment will evaluate adaptive control algorithms and measurement heirarchy for an evolving or deploying structure. It will include articulation and reconfiguration of payloads to change system mass properties and evaluate adaptive control design. The structure could be the same one deployed as payload GDCD 2201, and sequenced after 2201.

CODE G D C D 2 2 0 2

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ____ -
Inclination, deg Any Tolerance + ____ -
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☒ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	1000	
Standby	0	
Peak	1000	

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 1.0 Downlink Frequency (MHZ) ____

CODE G D C D 2 2 0 2

THERMAL

☐ Active ☐ Passive

Temperature, deg C — operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w — operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CH...ACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed
L,m 100 W,m ______ H,m ______ Deployed

Launch mass, kg 100

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2 Task Assignment Evaluate Control Approaches

Skills (See Table B)

SKILL	1	[illegible]				
LEVEL	2	2				
Hrs/Day	0.1	0.1				

EVA ☒ YES ☐ NO Reason Assembly/Reconfiguration Hrs/EVA 10

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day 180 Man/Hrs Req. 8
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Exper requires a stable environ to assure accurate measurements which would not be affected by Space Station. Low-g environ free from vibration perturbations. Random crew motion & on-board equip vibration must be minimized to achieve clean identification environ. A data acquisition facil would be necessary to record & analyze data. Uses struct from GDCD 2005. Weight is for sensors, controls, wiring only. If struct perturbations caused by activities on the SS can be minimized, the exper structure can be attached. No viewing/pointing req'ments. Thermal control not req.

GDCD CODE 2202 ELEMENT NAME ATT CNTRL-ADAPTIVE CNTL EXPERIMENT

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1994 INT. HRS 4 EVA HRS 4 EVA CREW 1

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.2 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 180 DAYS TOTAL RECONFIGS. 1

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 4

☐ NOT APPLICABLE EVA HRS PER RECONFIG. 4

EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

DATE(S) 1995 INT. HRS. 2 EVA HRS 2 EVA CREW 1

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Reconfigure structure of GDCD-2005, previously used in GDCD 2201, for this experiment.
3. Evaluate control approaches for multiple conditions
5. Remove experiment peculiar equipment not needed later

TOTAL EVA HRS 10

Code: GDCD 2202

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Attitude Control - Adaptive Control Experiment

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hq., 14-15 September 1982.

Narrative:

The payload element objective, description, special considerations, power and skill level are from Ref 1. Control of crew perturbations is assumed for the attached mode.

All other data is derived. This payload element is assumed to be able to use the structure provided by earlier experiments (Identified as GDCD 2005 & 2001). Therefore, the schedule is sequenced.

Code: GDCD 2202

PAYLOAD ELEMENT SYNTHESIS

ATTITUDE CONTROL - ADAPTIVE CONTROL EXPERIMENT

I. Mission Objectives

To validate performance and stability improvement sensing strategies and mechanization, control gain update subroutines and reconfiguration schemes, and adaptive control algorithms.

II. Mission Description

This experiment will evaluate adaptive control algorithms and measurement hierarchy for an evolving or deploying structure. It will include articulation and reconfiguration of payloads to change system mass properties and evaluate adaptive control designs.

III. Benefit

It is expected that new concepts in attitude control of large space structures will require the development of new algorithms as well as new measures of performance evaluation which will be developed during these experiments.

IV. Justification

Control of large space structures requires the understanding of new control algorithms, in parallel, with the development of various structural configurations. The Space Station provides a unique facility to develop these control schemes in an unlimited dimensional environment with zero gravity.

V. Mission Requirements and Capabilities

A) Orbital Parameters - High enough altitude to prevent drag effects on structure.

B) Mass, volume, operational envelope - Existence of a large structure as an appendage to the Space Station or as a free flying (or tethered) vehicle near the station.

C) Power - The power requirements would be on the order of a kilowatt for the excitation and data acquisition systems.

D) Thermal Control - no requirement

E) Attitude, Stabilization - The experiments must be done in an environment which is structually isolated from the Space Station to assure that the data is not affected by Station perturbations.

F) Viewing - no requirements

G) Environmental Constraints - Experiments require a low g environment with minimum vibrational perturbations from the Space Station.

H) Data Management, Communications - A data acquisition and analysis system would be necessary to record the data and develop control schemes in near real time.

I) Crew Timeline - Random crew motion and on-board equipment vibration must be minimized to achieve clean identification environment. In addition, the paylaod specialists must be able to reconfigure the structure to test the algorithm sensitivities to changes in the structural configuration.

J) Operations Schedule, Maintenance, Lifetime - TBD

VI. <u>Space Station vs. Free Flyer</u>

If the structural perturbations caused by activities on the Space Station can be minimized, then the experimental structure can be attached. Otherwise, a tethered or free flyer configuration must be used.

PAYLOAD ELEMENT NAME
Attitude Control, Distribution Control

CODE G D C D 2 2 0 3

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1995
No. of flights 1
Duration of Flight, days 365

OBJECTIVE

To validate hardware, algorithms and systems for active vibration damping, cooperative payload pointing, modular control, control during deployment, and precision pointing/stabilization.

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 12

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 9

DESCRIPTION The experiment consists of multipoint payload vibration/shape sensing with a sensor attached to the Space Station. Distributed actuation along the experimental structure will allow optimal placement of actuators and control schemes. Articulation and deployment of payloads will assist in further understanding of control variations as the structural configuration changes. A controlled coupling would exist at the interface between the structure and the Space Station. The structure could be the same one as deployed as payload GDCD 2201, and sequenced after 2202.

CODE G D C D 2 2 0 3

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ______ -
Inclination, deg Any Tolerance + ______ -
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec ______ Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☒ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	1000	
Standby	0	
Peak	1000	

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

CODE GDCD2203

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ____ max ____

non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____

non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ____ W,m ____ H,m ____ Stowed

L,m 100 W,m ____ H,m ____ Deployed

Launch mass, kg 100

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 2

Skills (See Table B)

Task Assignment: Evaluate Control Approach

SKILL	1	5				
LEVEL	2	2				
Hrs/Day	0.1	0.1				

EVA ☒ YES ☐ NO Reason Configuration Changes Hrs/EVA 10

SERVICING/MAINTENANCE

SERVICE: Interval, days ____ Consumables, kg ____

Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day 180 Man/Hrs Req. 8

Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions

Exper requires a stable environ to assure accurate measurements which would not be affected by Space Station. Low-g environ free from vibration perturbations. Random crew motion & on-board equip vibration must be minimized to achieve clean identification environ. A data acquisition facil would be necessary to record & analyze data. Uses struct from GDCD 2005. Weight is for sensors, controls, wiring only. If struct perturbations caused by activities on the SS can be minimized, the exper structure can be attached. No viewing/pointing req'ments. Thermal control not req.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 2203 ELEMENT NAME ATT CNTL-DISTRIBUTED CNTL EXP.

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1995 INT. HRS 4 EVA HRS 4 EVA CREW 1

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ______ DAYS TOTAL SERVICES ______

   ☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

   ☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

   EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.2 HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL 180 DAYS TOTAL RECONFIGS. ±

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 4

   ☐ NOT APPLICABLE EVA HRS PER RECONFIG. 4

   EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

   DATE(S) 1996 INT. HRS. 2 EVA HRS 2 EVA CREW 1

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Reconfigure structure of GDCD 2005, previously used in GDCD 2202, for this experiment
3. Evaluate control approaches
5. Remove experiment peculiar equipment not needed later

TOTAL EVA HRS 10

Code: GDCD 2203

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name:Attitude Control - Distributed Control Experiment

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hq., 14-15 September 1982.

Narrative:

The payload element objective, description, special considerations, power, and skill level are from Ref 1. The station-attached mode is required.

All other data is derived. This payload element is assumed to be able to use the structure provided by earlier experiments (Identified as GDCD 2005 & 2202). Therefore, the schedule is sequenced.

ATTITUDE CONTROL DISTRIBUTED CONTROL EXPERIMENT

I. Mission Objectives

To validate hardware, algorithms and systems for active vibration damping, cooperative payload pointing, modular control, control during deployment, and precision pointing/stabilization.

II. Mission Description

The experiment consists of multi-point payload vibration/shape sensing with a sensor attached to Space Station. Distributed actuation along the experimental structure will allow optimal placement of actuators and control schemes. Articulation and deployment of payloads will assist in further understanding of control variations as the structural configuration changes. A controlled coupling would exist at the interface between the structure and the Space Station.

III. Benefit

This experiment will be the final proof test of control techniques for various configurations of large space structures taking advantage of the control algorithms and concepts developed during the "adaptive control experiments."

IV. Justification

These experiments will validate the accuracy and precision of pointing and control of large space structures.

V. Mission Requirements and Capabilities

A) Orbital Parameters - High enough altitude to prevent drag effects on structure.

B) Mass, volume, operational envelope - Existence of a large structure as an appendage to the Space Station .

C) Power - The power requirements would be on the order of a kilowatt for the excitation and data acquisition systems.

D) Thermal Control - no requirement

E) Attitude, Stabilization - The experiments must be done in an environment which is as structually isolated from the Space Station as possible while being attached through a sensor.

F) Viewing - no requirements

G) Environmental Constraints - Experiments require a low g environment with minimum vibrational perturbations from the Space Station.

H) Data Management, Communications - A data acquisition and analysis system would be necessary to record the data and develop control schemes in near real time.

I) Crew Timeline - Random crew motion and on-board equipment vibration must be minimized to achieve clean identification environment. In addition, the paylaod specialists must be able to reconfigure the structure to test the algorithm sensitivities to changes in the structural configuration.

J) Operations Schedule, Maintenance, Lifetime - TBD

VI. Space Station vs. Free Flyer

Not applicable

PAYLOAD ELEMENT NAME
Advanced Adaptive Control

CODE GDCD2204

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1996
No. of flights 1
Duration of Flight, days 365

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 12

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

OBJECTIVE Evaluate adaptive control techniques required by advanced space station configurations. These adaptive control techniques will include closed-loop systems identification.

DESCRIPTION

Advanced adaptive control laws will be provided as selectable alternatives to operational control laws. Various advanced techniques will be evaluated with the operational system serving as a backup. The structure could be the same one deployed as payload GDCD 2201, and sequenced after 2203.

CODE
G D C D 2 2 0 4

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ____ -

Inclination, deg Any Tolerance + ____ -

Nodal Angle, deg ____ Ephemeris Accuracy, m ____

Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ____

Pointing accuracy, arc sec ____ Field of view, deg ____

Pointing Stability (Jitter) arc sec/sec ____

Special Restrictions (Avoidance) ____

POWER

☒ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	1000	
Standby	0	
Peak	1000	

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☒ Realtime ☒ Offline ☐ Other ____

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____

☐ On-Board Data Processing Required

Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____

Film (Amount) ____ Voice (Hrs/Day) ____

Live TV (Hrs/Day) ____ Other ____

On-Board Storage (MBIT) ____

Data Dump Frequency (Per Orbit) ____

Recording Rate (KBPS) 1.0 Downlink Frequency (MHZ) ____

CODE G D C D 2 2 0 4

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 100 W,m ______ H,m ______ Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 100

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2

Task Assignment Evaluate Control Approach

Skills (See Table B)

SKILL	1	5				
LEVEL	2	2				
Hrs/Day	0.1	0.1				

EVA ☒ YES ☐ NO Reason Assembly/Reconfiguration Hrs/EVA 10

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day 180 Man/Hrs Req. 8
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Exper requires a stable environ to assure accurate measurements which would not be affected by Space Station. Low-g environ free from vibration perturbations. Random crew motion & on-board equip vibration must be minimized to achieve clean identification environ. A data acquisition facil would be necessary to record & analyze data. Uses struct from GDCD 2005. Weight is for sensors, controls, wiring only. If struct perturbations caused by activities on the SS can be minimized, the exper structure can be attached. No viewing/pointing req'ments. Thermal control not req.

GDCD CODE 2204 ELEMENT NAME ADV ADAPTIVE CNTL TECHNOLOGY DEMO

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1996 INT. HRS 4 EVA HRS 4 EVA CREW 1

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.2 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 180 DAYS TOTAL RECONFIGS. 1

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. 4

☐ NOT APPLICABLE EVA HRS PER RECONFIG. 4

EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

DATE(S) 1997 INT. HRS. 2 EVA HRS 2 EVA CREW 1

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Reconfigure structure of GDCD 2005, previously used in GDCD 2202 for this demo mission.
3. Evaluate control approaches
5. Remove experiment equipment not needed later

TOTAL EVA HRS 10

Code: GDCD 2204

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Advanced Adaptive Control - Technology Demonstration

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hq., 14-15 September 1982.

Narrative:

The payload element objective, description, special considerations, and skill level are from Ref 1. Station-attached operation is required.

All other data is derived. This payload element is assumed to be able to use the structure provided by earlier experiments (Identified as GDCD 2005 & 2203). Therefore, the schedule is sequenced.

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title:
Spacecraft Control Technology Development

Langley Contact:
L. W. Taylor, Jr.

Experiment Title:
Advanced Adaptive Control Technology Demonstration

Mission Objectives:
Evaluate adaptive control techniques required by advanced space station configurations. These adaptive control techniques will include closed-loop systems identification.

Mission Description:
Advanced adaptive control laws will be provided as selectable alternatives to operational control laws. Various advanced techniques will be evaluated with the operational system serving as a backup.

Benefit:
Systems identification and adaptive control technology must continue to evolve as space stations become more complex and flexible. Advanced techniques must be validated prior to operational use.

Justification:
Technology supports space station evolution and therefore requires realistic large flexible structures as a test bed. Ground testing of this technology is not possible.

Mission Requirements and Capability:
Essentially the same as the operational control system. Expanded or modified computational capability is anticipated.

Space Station vs. Free Flyer:
Technology applies to multibody, flexible space stations as opposed to single body, relatively stiff free flyers.

Section 3.4

Discipline Propulsion

GDCD ID NO.	PAYLOAD ELEMENT NAME
2301	Controlled Acceleration Propulsion Technology
2302	Laser Propulsion Test

PAYLOAD ELEMENT NAME
Controlled Accel Propulsion Tech

CODE G D C D 2 3 0 1

CONTACT
Name
Address
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General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1994
No. of flights 1
Duration of Flight, days 180

OBJECTIVE Determine the reasibility, characteristic, constraints, and interfaces of propulsion systems required for controlled acceleration of space systems and correlate the ground and space characteristics of candidate concepts.

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number 13
(see Table A)

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 9

DESCRIPTION Candidate low thrust propulsion concepts will be attached to the Space Station or associated space system if program objectives so indicate. The propulsion system will be operated to determine the feasibility of and constraints on their use to control accelerations induced by natural and space system forces and torques. Associated diagnostics will assess plume characteristics which cannot be adequately evaluated in ground tests. The performance and lifetime will be evaluated by the use of flight and post flight inspections to correlate space and ground results. The specific propulsion concepts to be evaluated will include resistojets operated (1) in several modes which affect their dynamic thrust characteristics and (2) with various propellants.

CODE G D C D 2 2 0 1

ORBIT CHARACTERISTICS
Apogee, km LEO Perigee, km LEO Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION
View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER
☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	1500	
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS
Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

ORIGINAL PAGE IS
OF POOR QUALITY

CODE G D C D 2 3 0 1 — Page 3 of 3

THERMAL

☐ Active ☒ Passive

Temperature, deg C — operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w — operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

	L,m	W,m	H,m
Stowed			
Deployed	0.6	0.4	0.4

Launch mass, kg 45

Consumables Types Resistor-Jet Fuel

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1 Task Assignment ______

Skills (See Table B)

SKILL	7					
LEVEL	2					
Hrs/Day	0.2					

EVA ☒ YES ☐ NO Reason Assembly/Service/Remove Hrs/EVA 10

SERVICING/MAINTENANCE

SERVICE: Interval, days 90 Consumables, kg 20
Returnables, kg ______ Man Hours 4

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Assumed to use noncryogenic propellants. Assumed attached accommodation requires controlled station acceleration during operations.

GOCD CODE 2301 ELEMENT NAME CONTROLLED ACCELERATION PROPULSION TECHNOLOGY

ACCOMODATION: [X] ATTACHED [ ] FREE FLYER [ ] OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1994 INT. HRS 4 EVA HRS 4 EVA CREW 1

[ ] NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 90 DAYS TOTAL SERVICES 1

[ ] TMS/OTV REQUIRED ______ STATION HRS PER SERVICE 2

[ ] NOT APPLICABLE ______ EVA HRS PER SERVICE 2

EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.2 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

[ ] NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

[ ] TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

[X] NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) 1994 INT. HRS. ______ EVA HRS 4 EVA CREW 1

[ ] NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Set up and checkout engine assembly
2. Replenish propellant
3. 2-8 hour runs per 90 day period. 4 total - operate engine and collect data.
5. Remove engine assembly and package for return.

TOTAL EVA HRS 10

Code: GDCD 2301

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Controlled Acceleration Propulsion Technology

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hq., 14-15 September 1982.

Narrative:

Basic concept, timing, orbit, power, size, mass, and thermal from Ref 1. Attached mode selected to provide full achievement of objectives and evaluation of data. Mission not suitable for space Shuttle due to Shuttle mission characteristics and constraints.

Code: GDCD 2301 PAYLOAD ELEMENT SYNTHESIS

CONTROLLED ACCELERATION PROPULSION TECHNOLOGY

I. Mission Objective

Determine the feasibility, characteristic, constraints, and interfaces of propulsion systems required for controlled acceleration of space systems and correlate the ground and space characteristics of candidate concepts.

II. Mission Description

Candidate low thrust propulsion concepts will be attached to the Space Station or associated space system if program objectives so indicate. The propulsion systems will be operated to determine the feasibility of and constraints on their use to control accelerations induced by natural and space system forces and torques. Associated diagnostics will assess plume characteristics which cannot be adequately evaluated in ground tests. The performance and lifetime will be evaluated by the use of flight and post flight inspections to correlate space and ground results. The specific propulsion concepts to be evaluated are TBD but will include resistojets operated (1) in several modes which affect their dynamic thrust characteristics and (2) possibly with various propellants.

III. Benefit

Sustained controlled acceleration environments for space systems are enabled by low thrust, precisely controlled, propulsion systems.

IV. Justification

Shuttle mission characteristics, priorities, and constraints preclude its use for the evaluation of acceleration control as well as the full accomplishment of correlation of space and ground characteristics. Ground tests are inadequate due to limited pumping, "wall effects", and the lack of sustained low "g" availability.

V. Mission Requirements and Capabilities

A) Orbital Parameters - No constraints except altitudes above those which produce an overall drag of 10-3 "g" or greater.

B) Mass, volume, operational envelope - TBD but the dry mass, including power will typically less than 25KG. The propellant mass is dependent on experiment conditions but would be expected to be less than 20KG. The volume of individual propulsion systems will be less than 0.1 M3. Operational envelope is TBD.

C) Power - Continuous power during the experiment. Either AC or DC power is acceptable but DC is desirable. Other interface requirements are TBD. The magnitude will be greatly dependent on the experiment but would be about 1.5 KW if a full SOC (50KW size) concept were used at 350 KM and correspondingly smaller for smaller experimental platforms at higher altitudes.

D) Thermal Control- Except for propellant management, there are no thermal control interface requirements. For non-cryogenic propellants it is likely that the thermal control will be contained within the experiment by design. For cryogenic propellants thermal control requirements are TBD.

E) Attitude, Stabilization - No fundamental constraints except for (1) a degree of constancy, and/or control, of accelerations on the Space System during acceleration control phases of the experiment, and (2) attitudes required to avoid impacts of the plumes from the propulsion systems.

F) Viewing- No requirements.

G) Environmental Constraints - TBD

H) Data Management, Communication - Basic experiment control is closed loop except for commands to initiate, change state, and terminate the experiment in planned formats. No real time data required except as determined to be needed for space system safety.

I) Crew Timelines - Could be impactive if the experiment is on a manned space system. If crew movements and actions do not affect the experiment, such as on a free flyer or a loose coupled attached structure, the impact of the experiment is probably negligible.

J) Operations Schedule, Maintenance, Lifetime - No maintenance planned. Schedule and lifetime are experiment specific and are TBD.

IV. Space Station VS. Free Flyer

It is likely that uncontrolled accelerations generated on a Space Station from any source are not acceptable. Approaches to avoid such accelerations are TBD but clearly could include free flyers. If free flyers were employed the objectives of evaluation of acceleration control could be achieved without retrieval but full evaluation of the performance, lifeti e, and plume interfaces could not, as post test data are required.

PAYLOAD ELEMENT NAME
Laser Propulsion Test

CODE G D C D 2 3 0 2

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1996
No. of flights 1
Duration of Flight, days 180

OBJECTIVE To measure the thrust and specific impulse of one or more laser propulsion systems, and to assess the adequcy of ground-based measurements, and to test the life expectancy of a laser engine.

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 13

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

DESCRIPTION

The mission will be the first systems level test of laser propulsion in space. It will test thrust and specific impulse as well as system characteristics such as steady-state wall temperature, propellant mass flow rate. A high-power laser, either solar-pumped or electrically pumped, will be required for this mission. Life tests will be performed.

ORIGINAL PAGE IS
OF POOR QUALITY

CODE
G D C D 2 3 0 2

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ______ - ______
Inclination, deg Any Tolerance + ______ - ______
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec ______ Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	200	
Standby		
Peak		

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 5 Downlink Frequency (MHZ) ______

CODE GDCD2302

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m 1.5 W,m 0.5 H,m 0.5 Deployed

Launch mass, kg 100

Consumables Types H_2

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1 Task Assignment ______

Skills (See Table B)

SKILL	7					
LEVEL	2					
Hrs/Day	0.25					

EVA ☒ YES ☐ NO Reason Assembly/Service/Remove Hrs/EVA 18

SERVICING/MAINTENANCE

SERVICE: Interval, days 30 Consumables, kg 20

Returnables, kg ______ Man Hours 4

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Laser available from mission GDCD 2105 and collector of 2104. Additional power for controls and instrumentation.

GDCD CODE 2302 ELEMENT NAME LASER PROPULSION TEST

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1996 INT. HRS 4 EVA HRS 4 EVA CREW 1

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL 30 DAYS TOTAL SERVICES 5

   ☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE 2

   ☐ NOT APPLICABLE ______ EVA HRS PER SERVICE 2

   EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.25 HRS PER DAY (INTERNAL)

   ______ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ______ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) 1996 INT. HRS. ______ EVA HRS 4 EVA CREW 1

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Set up and checkout engine assembly with existing collector (Ref GDCD 2104 and 2105)
2. Replenish H_2
3. Total 8 hrs run time per month in two test periods
5. Remove engine assembly and package for return

TOTAL EVA HRS 18

Code: GDCD 2302 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Laser Propulsion Test

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hq., 14-15 September 1982.

2. Performance and Heat Transfer Characteristics of the Laser-Heated Rocket, NASA 76-1044.

3. Laser Propulsion, NASA TM X-2510

Narrative:

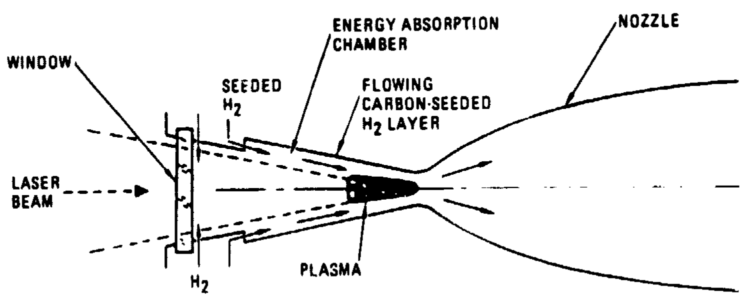
Basic concept and timing from Ref 1. Other data was derived. Man required for deployment to achieve objectives and assure safety (Ref 1). Ref 2 & 3 used for background see pp 2, 3.

Characteristics are as follows:

Laser power 50 kW
Eng. thrust 0.73 Kgf
ISP 1000 sec

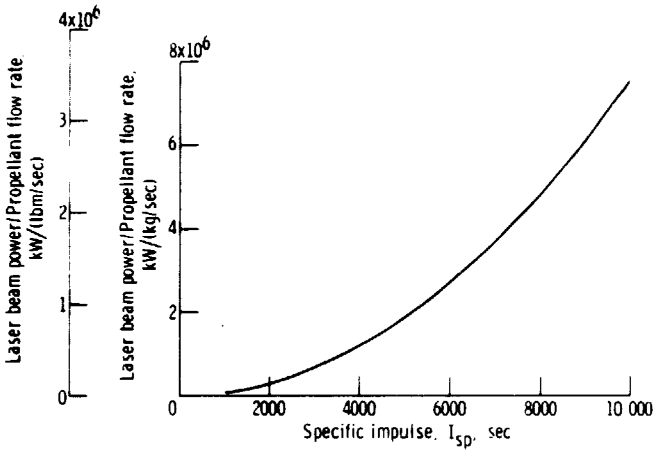
The following description and figures are extracted from Ref 2.

"In the operation of a laser-heated rocket thruster of the type to be discussed in this paper, the laser beam energy would enter the thruster assembly through a (solid) window, into the "energy absorption" chamber (Fig 1). The energy would be absorbed by the propellant via inverse Bremsstrahlung, resulting in formation of a high-temperature plasma. This propellant or working fluid flow would consist of a gas (i.e., hydrogen is the prime candidate because of its low molecular weight) which may or may not contain a seeding material to enhance plasma radiation absorption. The focused laser beam would sustain the high-temperature plasma within the chamber. This plasma, through conduction and radiation, would transfer heat to the remaining propellant. The high-temperature propellant would then be expanded through a conventional rocket nozzle to produce the thrust force."



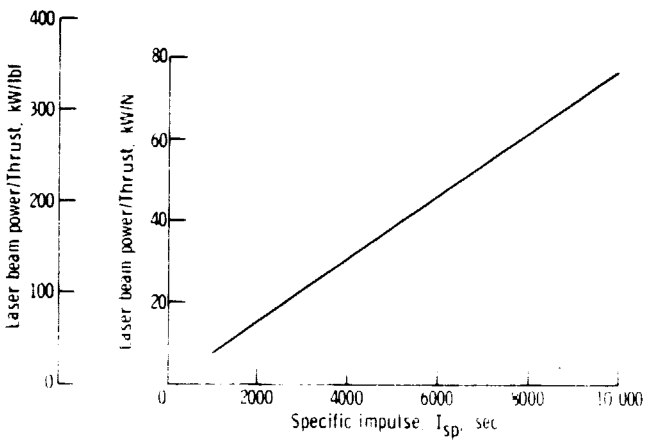
Laser-Heated Rocket Thruster

266.592-466



266.592-467

Beam Power Per Unit of Propellant Flow Rate for Various Specific Impulses



266.592-468

Beam Power Per Unit of Thrust for Various Spacific Impulses

Code: GDCD 2302 PAYLOAD ELEMENT SYNTHESIS

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title: Advanced Energetics Research - IV **Langley Contact**: E. J. Conway

Experiment Title: Laser Propulsion Test

Mission Objectives: To measure the thrust and specific impulse of one or more laser propulsion systems, and to assess the adequacy of ground-based measurements, and to test the life expectancy of a laser engine.

Mission Description: The mission will be the first systems-level test of laser propulsion in space. It will test thrust and specific impulse as well as system characteristics such as steady-state wall temperature, propellant mass flow rate. A high-power laser, either solar-pumped or electrically pumped, will be required for this mission. Life tests will be performed.

Benefit: Studies show that laser propulsion offers large cost savings for OTV's operating in a heavy traffic mode. By the early 1990's, prototype laser propulsion systems will be developed and tested on the ground. Their further development will require verification by a space test of the performance in test chambers. This mission is designed to test propulsion system parameters and establish a reliable estimate of benefit.

Justification: Several studies have shown that laser propulsion for OTV applications could be much less expensive than chemical propulsion. Without aggresive research, technology development will not be realized. This mission is designed to demonstrate and advance the state of the art in laser propulsion.

Mission Requirements and Capability: An adequate laser power source operating at the correct optical frequency will be required. Laser pointing and tracking will not be required since transmission can be over a distance of approximately the longest dimension of the space station. Adjustment, control, alignment, and repair are expected to require manned interaction. Depending upon the magnitude of the laser thrust, an opposed non-laser engine may be required.

Space Station vs. Free Flyer: These tests will require man for deployment, to achieve and measure maximum performance and to assure safety for the spacecraft and the laser propulsion system. Because it requires a high-power laser, either solar-pumped (requiring the concentrator) or electrically pumped (requiring a large photovoltaic panel), the resources of a space station will be required.

Section 3.5

Discipline Control & Human Factors

GDCD ID NO.	PAYLOAD ELEMENT NAME
2401	Manipulator Controls Technology
2042	Advanced EVA Technology

PAYLOAD ELEMENT NAME
Manipulator Controls Technology

CODE G D C D 2 4 0 1

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1991
No. of flights 1
Duration of Flight, days 365

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 14

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 6

OBJECTIVE To determine the characteristics and limitations of interactive and adaptive control technology applied to space teleoperator systems. To develop a quantitative data base with which to compare and predict task performance with teleoperation vs space suit.

DESCRIPTION A lightweight low-inertia dual arm manipulator system will be attached to the Space Station. The manipulator system will be controlled from a teleoperator control station in the Space Station, through a computer interface, using both supervisory and direct control modes. Initially, tests within a Space Station laboratory will include evaluation of system response to validate ground based models, to identify system parameters, and to develop adaptive control algorithms for 0-g operations. Experiments will provide data on operator restraints, workload, mobility, and response to bilateral forces. Baseline test will be conducted to compare task performance using the teleoperator with performance in a space suit. In addition to tests within the Space Station, the teleoperator system will be attached to a carrier vehicle such as TMS to develop procedures for remote operations such as construction, inspection and repair.

ORIGINAL PAGE IS
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CODE
G D C D 2 4 0 1

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☒ DC

	Power, W	Duration, hrs/day
Operating	3150	
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☒ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 1 Downlink Frequency (MHZ) ____

CODE G D C D 2 4 0 1

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☒ Internal ☐ External ☐ Remote

Equipment ID/Function ☒ Pressurized ☐ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m 3 W,m 2 H,m 2 Deployed

Launch mass, kg 600

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2 Task Assignment Evaluate Manipulator System Response

Skills (See Table B)

SKILL	1	5				
LEVEL	2	2				
Hrs/Day	0.2	0.2				

EVA ☒ YES ☐ NO Reason Set Up/Operations Hrs/EVA 20

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions Crew scheduling will be necessary, but teleoperation technology studies schedule can be flexible. Operations outside the Space Station will significantly affect crew timelines. RF link for TV and command/feedback will be required for remote teleoperator control (with TMS or other free-flyer). Outputs of system will be monitored and some parameters recorded. Onboard data analysis capability is desirable. Deployed dimensions are expected envelope for internal operations.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GOCD CODE 2401 ELEMENT NAME MANIPULATOR CONTROLS

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1991 INT. HRS ______ EVA HRS 8 EVA CREW 2

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ______ DAYS TOTAL SERVICES ______

   ☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

   ☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

   EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   0.38 HRS PER DAY (INTERNAL) 138 hrs/365 days

   0.03 HRS PER DAY (EVA) 12 hrs/365 days

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ______ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) 1992 INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

   See payload element synthesis sheet.

TOTAL EVA HRS 20

Code: GDCD 2401 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Manipulator Controls Technology

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hq., 14-15 September 1982, Attachment A, p 60.

Narrative:

This payload element implements the experiment objectives described in Ref 1.

Initial experiments are conducted within a Space Station Laboratory using two 3m long arms.

Later tests will be performed with two 6m long arms attached to a carrier vehicle such as a TMS. The weight and power estimates shown on the data sheets are for this latter case. Mass and power estimates are given in Table 2401-1.

The suited man performance equivalence tests will require 8 hours of EVA to set up the task board and 4 hours of EVA to conduct the test. Table 2401-2 lists sthe man hour utilization for each phase of the experiment.

Table 2401-1. Mass and Power Estimates*

	Mass (kg)	Power (W)
A. Internal Tests:		
(2) 3m Arms	260	1,000
(1) controls, Displays	50	150
Totals:	310	1,150
B. External Tests:		
(2) 6m Arms	550	3,000
(1) Controls, Displays	50	150
Totals:	600	3,150

*Estimated by Spar Ltd.

Code: GDCD 2401 PAYLOAD ELEMENT SYNTHESIS

Table 2401-2. Manhour Utilization

		Manhours
1.	Laboratory Expt.	
1A.	Short Arm Tests	
	Set up & conduct 8 test runs.	
	2 crewmen required x 54 hrs each =	108
1B.	Suited Man Performance Test	
	Suit up and conduct taskboard tests	
	2 crewmen required x 3 hrs each =	6
2.	TMS Conversion	
2A.	Adapt Manipulators To TMS	
	2 men x 4 hrs =	8
2B.	Checkout Operation	
	2 men x 2 hrs =	4
2C.	Locate Task Board Externally	
	2 EVA crewmen x 4 hrs =	8 (EVA)
3.	External Experiments	
3A.	TMS Perf. Test	
	2 men x 4 hrs =	8
3B.	EVA - Man Perf. Test	
	1 man EVA 4 hrs =	4 (EVA)
	1 man IVA 4 hrs =	4
	Total:	150 (including 12 hrs EVA)

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title: Space Teleoperator Systems Research Langley Contact: A. J. Meintel

Experiment Title: Manipulator Controls Technology

Mission Objectives: 1. Determine the characteristics and limitations of interactive and adaptive control technology applied to space teleoperator systems. 2. To develop a quantitative data base with which to compare and predict task performance with teleoperation and in a space suit.

Mission Description: A lightweight low-inertia dual-arm manipulator system will be attached to the space station or associated structure. The manipulator system will be controlled from a teleoperator control station in the space station, through a computer interface, using both supervisory and direct control modes.

Initially, the manipulator system will be in a space station laboratory. Tests within the laboratory will include evaluation of system response-to validate ground based models, to identify system parameters, and to develop adaptive control algorithms for zero g operations. Experiments will provide data on operator restraints, workload, mobility, and response to bilateral forces. Baseline tests will be conducted to compare task performance using the teleoperator with performance in a space suit.

In addition to tests within the space station the teleoperator system will be attached to a carrier vehicle such as TMS to develop the technology and integrated procedures required for remote operations such as construction, inspection, materials transfer, and repair.

Benefit: A teleoperation system will perform activities outside the space station (EVA) over a long time period, over long distances, with precision, without human risk, and with replinishable electrical power the only consumable. A teleoperator can capture, transport, orient, and stabilize materials and payloads needed for EVA operations.

Justification: The Shuttle RMS is the first space teleoperator. It also illustrates the handicap in development of space teleoperator technology. The RMS, like all manipulators, is a flexible, coupled, nonlinear system. The stabilization and control problems are analogous to those of other large space structures. The RMS can (and had been) mathematically modelled, but because it is designed for zero g it cannot be tested under 1g to validate its characteristics and develop control laws that will improve its response and stability. Neutral buoyancy tests would require structural changes and would have large viscous effects. A space station would provide the time to systematically validate the math models and improve the performance based on the true measured characteristics of a space-based teleoperator system.

Also, many teleoperator systems employ bilateral force feedback because it gives the operator an indication of the forces exerted on the manipulator end effector or tool. The RMS is not a force reflecting system and the aft flight deck has limited space. The space station would have room for conventional and bilateral controllers, and the effects of forces transmitted to the operator and the restraints required for zero g could be evaluated.

Mission Requirements and Capabilities:

Mass, volume, operational envelope- All configuration dependent. TBD.

Data management, communication- Outputs of system will be monitored and some parameters recorded. Onboard data analysis capability desirable.

RF link for TV and command/feedback required for remote teleoperator control (with TMS or other free-flyer).

Crew Timeline- Crew scheduling will be necessary, but teleoperation technology studies schedule can be flexible. Operations outside space station will significantly effect crew timelines.

PAYLOAD ELEMENT NAME
Advanced EVA Technology

CODE G D C D 2 4 0 2

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 3600

OBJECTIVE Develop the tools, EVA workstations, mobility aids, and procedures to perform diverse EVA tasks (station construction, OTV/satellite servicing, emergencies), effectively, efficiently, safely, on a continuing basis for as many as 24 sorties per week.

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 14

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

DESCRIPTION In conjunction with life sciences payload element GDCD 0322, new tools for Space Station construction, maintenance and repair, restraint systems, mobility aids, EVA work platforms, new suit components (initially, the new 8 psi "hard" suit) and other EVA equipment and procedures will be used and evaluated. This payload will consist of stowed equipment and electrical/data interface for remote control, monitoring and display. Advanced EVA tools and equipment will be developed and used for assembly/construction of large space structures and systems on the Space Station throughout the decade.

ORIGINAL PAGE IS
OF POOR QUALITY

CODE
G D C D 2 4 0 2

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	100	
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

ORIGINAL PAGE IS
OF POOR QUALITY

CODE G D C D 2 4 0 2

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☐ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☐ Unpressurized

L,m 1.3 W,m 1.3 H,m 1.3 Stowed

L,m 1.3 W,m 1.3 H,m 1.3 Deployed

Launch mass, kg 500

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1 Task Assignment EVA

Skills (See Table B)

SKILL		7				
LEVEL		1				
Hrs/Day		0.02				

EVA ☒ YES ☐ NO Reason Operations Hrs/EVA 160

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions This payload element is interactive with GDCD 0322, EVA Performance and Productivity. Required EVA time of 0.04 Hr/Day are charged to this payload element. In later years, weight could increase to 812 Kg and 4.0 cubic meters which includes spares and tools. This payload element supports a variety of assembly and construction activities of large structures on the Station, e.g., GDCD 2005, 2006, 2007, 0001.

GDCD CODE 2402 ELEMENT NAME ADVANCED EVA TECHNOLOGY

ACCOMODATION: [X] ATTACHED [ ] FREE FLYER [ ] OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1990 INT. HRS ______ EVA HRS ______ EVA CREW ______

[ ] NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ______ DAYS TOTAL SERVICES ______

[ ] TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

[X] NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

.02 HRS PER DAY (INTERNAL)

.04 HRS PER DAY (EVA) Total of 160 hours

[ ] NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

[ ] TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

[X] NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

[X] NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. No assembly required
3. EVA = 20 times, 2 men for 4 hr. each time
5. Continuing experimentation after year 2000

TOTAL EVA HRS 160

Code: GDCD 2402

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Advanced EVA Technology

Reference Documents:

1. Space Station Technology Readiness by R.F. Carlisle and J.H. Romero. ASME National Marketing, Phoenix, Arizona, November 1982

2. Space Station Environmental Control and Life Support System. Preliminary Conceptional Design by C.H. Lin. NASA JSC Doc No. CSD-53-059, JSC-17727, 9/82

3. Military Space Systems Technology Model. AIAA Man-In-Space System Panel Report, Alburquerque, N.M. Revised Draft, September 23, 1982

4. Space Operation Center Systems Analysis. Final Report. Volume II. Boeing Aerospace Company. NASA Contractor Report 160944 (JSC). July 6, 1982.

Narrative:

Future EVA space activity shows a diversity of work on a continuing basis, exceeding past work, including space station construction, OTV and satellite servicing, as well as emergences requiring immediate EVA activity. Improved EVA equipment, adapted to the new activities, will need to be tested under the required continuing basis, which will not be possible from periodic space shuttle-based EVAs.

Planned EVA technology to enhance space work encompasses items such as (see Ref 1, p 12 and Ref 2, p 86):

Suit construction:	Improved mobility
Suit life support system:	Improved internal pressure (8 psi vs 4 psi), and atmosphere composition (O_2, N_2 vs O_2 today)
Work tools, maneuvering unit:	Enhanced mission abilities (powered vs no power) greater operating distances with an improved manned maneuvering unit.

The higher pressure and component gases avoid lengthy pre-breathing (bend avoidance) required for existing space suits.

Ref 3 lists elapsed time through manufacturing and test for developing eleven EVA technology related items; namely:

1. EMU Helmet (3yrs)
2. EMU Gloves (3 yrs)
3. Refueling System (4 yrs)
4. Hand Tools (3 yrs)
5. Prebreathe Eliminator (6 yrs)
6. Hand-Held Power Tool (3 yrs)
7. Diagnostic & Checkout (6 yrs)
8. Enhanced Computer (11 yrs)
9. Rengenerable CO_2 (5 yrs)
10. Non Venting Heat Sink (3 yrs)
11. Hi ΔV MMU (8 yrs)

Ref 3 describes safety aspects related to EVA (p 4-22).

Integration of EVA and Space Station are described in Ref 2, p 6, and following:

(a) preparations
(b) equipment storage
(c) recharge
(d) checkout
(e) maintenance
(f) past EVA activities

- Storage of EMU spare parts and tools to be located in the maintenance area.

- Checkout of EVA equipment, repairs, etc is to be done in the work area

Eva activity level described by NASA in Ref 2, p 7 is:

- Capability of two EVAs simultaneously in early years
- Capability of four Evas simultaneously in later years
- EVA frequency: Two, 2-man sorties/day, 6 days/week for a total of 24 sorties/week
- Maximum duration of 8 hours/sortie

The Convair mission data for this payload shows an 8-hour/day estimate for the early years, rather than the 16 hours indicated above.

Table 2402-1 summarizes weight and volume for the space suits. See Ref 3, pp 3-4 for data/suit. Table 1 contains an estimate of suits required to which is added a judgemental 30% weight and volume increase for spares and tools.

Existing space suits use a replaceable lithium hydroxide (Li OH) canister (6.5 lb/EVA) to remove CO_2. If the canister use is kept, corresponding weight (24 sorties/week) = 1900 lb (849 kg). This is a significant amount relative to suit weights in Figure 2402-1. A regenerable CO_2 for extensive EVAs is one of the planned items listed previously. For the purpose of weight estimates, the above assumption of a 30% increase applied in Figure 1 is taken to approximate the inclusion of any Li OH.

Power requirements in Figure 2402-1 is taken at 30 watts/suit (battery) based on a phone discussion with Mr. A. Brouillet of Hamilton Standard Company, an EVA suit manufacturer.

Table 2402-1. Space Suit Data (8 psi, O_2 IN_2)

Year	Crew Sizes	No. of Suits	Wt. Per Suit, KG *	Volum Per Suit, cu.m*	Sum Weight, kg **	Sum Volume, cu.m **	Sum Power, W
Early	4	3	104	0.5	406	2.0	100
Later	8	6	104	0.5	812	4.0	180

* Ref 3, pp 3-48

** Includes 30% extra for spares and tools

Section 3.6

Discipline Space Station Systems & Operations

GDCD ID NO.	PAYLOAD ELEMENT NAME
2501	Liquid Droplet Radiator
2502	Advanced Control Device
2503	Space Component Lifetime Technology
2504	OTV Payload Handling
2505	Pdyload Servicing and Repair
2506	OTV Propellant Transfer and Storage
2507	OTV Propellant Reliquification
2508	OTV Docking and Berthing
2509	OTV Maintenance
2510	Tether Dynamics Technology

PAYLOAD ELEMENT NAME
Liquid Droplet Radiator

CODE G D C D 2 5 0 1

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1996
No. of flights 1
Duration of Flight, days 365

OBJECTIVE Demonstration and verification of an advanced Liquid Droplet space radiator concept under operational Space Station conditions (0-g, space vacuum, space plasma, attitude control maneuvering perturbation, long duration operations). Determine operational characteristics, constraints, and effects of space station/radiator interface.

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 15

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 7

DESCRIPTION

The liquid droplet radiator systems could be connected to the Space Station thermal management system. The system would be installed as an auxiliary experimental heat rejection system. Waste heat load would be supplied by the Space Station commensurate to the size of the liquid droplet radiator system. It would operate at actual Space Station radiator conditions of inlet and outlet temperature, etc. Performance would be evaluated for efficiency of waste heat rejection, response, temperature distribution controllability, flow rate, potential of loss of working fluid, and space station contamination due to vaporization and maneuvering. 0-g effects on droplet generation, trajectory and collection efficiency would be determined, as well as constraint on operation control and performance. Performance, failure modes, and lifetime potential will be evaluated.

CODE G D C D 2 5 0 1

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ___ - ___
Inclination, deg Any Tolerance + ___ - ___
Nodal Angle, deg ___ Ephemeris Accuracy, m ___
Escape dV Required, m/s ___

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ___
Pointing accuracy, arc sec ___ Field of view, deg ___
Pointing Stability (Jitter) arc sec/sec ___
Special Restrictions (Avoidance) ___

POWER

☒ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	1000	
Standby	0	
Peak	1000	

☒ Continuous

Voltage, V ___ Frequency, Hz ___

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other ___
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ___ Frequency (MHZ) ___
☐ On-Board Data Processing Required
Description ___

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ___
Film (Amount) ___ Voice (Hrs/Day) ___
Live TV (Hrs/Day) ___ Other ___
On-Board Storage (MBIT) ___
Data Dump Frequency (Per Orbit) ___
Recording Rate (KBPS) 1.0 Downlink Frequency (MHZ) ___

CODE GDC02501

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ____ max ____

non-operational min ____ max ____

Heat Rejection, w operational min ____ max ____

non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ____ W,m ____ H,m ____ Stowed

L,m ____ W,m ____ H,m ____ Deployed

Launch mass, kg 1000

Consumables Types ____

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 1 Task Assignment Verify Radiator Concept

Skills (See Table B)

SKILL	1					
LEVEL	2					
Hrs/Day	0.1					

EVA ☒ YES ☐ NO Reason Deployment/Removal Hrs/EVA 20

SERVICING/MAINTENANCE

SERVICE: Interval, days ____ Consumables, kg ____

Returnables, kg ____ Man Hours ____

CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____

Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions Mission would require evaluatioan under start-up, shutdown, full and part load operation. Experiment control is required to initiate operation, terminate operation, and change operating level per waste heat rejection demands. Data acquisition is required for operational control and evaluation. System would be designed to operate within the attitude and stabilization constraints of the space station. Position control of the liquid droplet steam collector may be required. It is anticipated that this would be effected through motorized control, method TBD. No thermal control required.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 2501 ELEMENT NAME LIQUID DROPLET RADIATOR

ACCOMODATION: [X] ATTACHED [ ] FREE FLYER [ ] OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1996 INT. HRS ___ EVA HRS 12 EVA CREW 2

[ ] NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ___ DAYS TOTAL SERVICES ___

[ ] TMS/OTV REQUIRED ___ STATION HRS PER SERVICE ___

[X] NOT APPLICABLE ___ EVA HRS PER SERVICE ___

EVA CREW SIZE ___

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.2 HRS PER DAY (INTERNAL)

___ HRS PER DAY (EVA)

[ ] NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ___ DAYS TOTAL RECONFIGS. ___

[ ] TMS/OTV REQUIRED STATION HRS PER RECONFIG. ___

[X] NOT APPLICABLE EVA HRS PER RECONFIG. ___

EVA CREW SIZE ___

5. DEACTIVATION/REMOVAL

DATE(S) 1997 INT. HRS. ___ EVA HRS 8 EVA CREW 2

[ ] NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Deployment of collector, plumbing
3. Monitoring of Performance
5. Removal of experiment

TOTAL EVA HRS 20

Code: GDCD 2501

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Liquid Droplet Radiator (LDR).

Reference Documents:

1. Technology Development Missions Space Station NAAO Orientation Meeting NASA Hq., 14-15 September 1982.

2. The Liquid Droplet Radiator - An Ultra Light Heat Rejection System For Efficient Energy Conversion In Space, A.T. Mattick and A. Hertzberg, Acta Astronautica Vol. 9 pp 165-172, 1982.

Narrative:

The objective, description and special considerations for this payload element are from Ref (1).

The concept sketch for LDR generation and collector are from Ref (2).

The remaining data for this payload element is derived.

Ref (2) identifies unique interfaces, to include:

a. Contamination of spacecraft surfaces and radiation fluid (typical fluids are tin, tin-lead, oils, etc)
b. Droplet charging from the space station which could effect droplet trajectory
c. Radiator orientation to insure droplet pattern edge-on to the sun and integration and coordination of station attitude changes with droplet collector position.

Methods of generating and collecting the droplets are shown in Figure 2501-1 from Ref (2) and as follows: "The generator is a pressurized plenum with an array of nozzles to form liquid jets which break up into droplets via surface tension instability. A vibrator may be used to induce pertubations in the emerging jets to control droplet size and spacing."

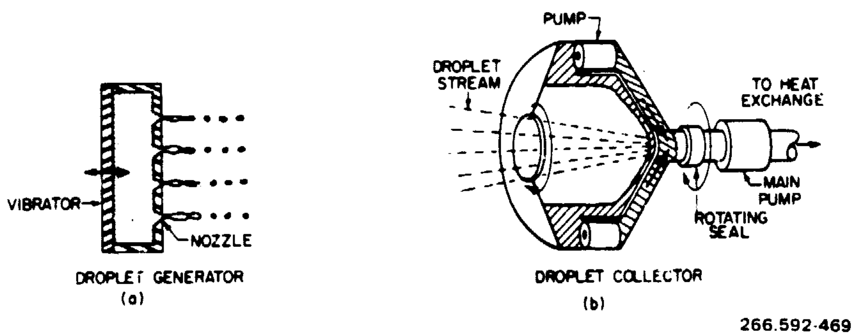


Figure 2501-1. **LDR Components, (a) Generator; (b) Collector**

LIQUID DROPLET RADIATOR

I. Mission Objective

Demonstration and technical verification of an advanced Liquid Droplet space radiator concept under acutal operational space station conditions (zero-gravity, space vacuum, space plasma, attitude control manuevering perturbation, etc., during long duration operations). Determine operational characteristics, constraints and effects of space station/radiator interface.

II. Mission Description

The candidate liquid droplet radiator systems could be intergrated/connected to the space station thermal management system at the heat rejection interface point. The system assembly would be installed as an auxilliary experimental heat rejection system. Waste heat load would be supplied by the space station (as an option a separate heat source could be used) commensurate to the size of the liquid droplet radiator system. It would operate at actual space station radiator conditions of inlet and outlet temperature, zero gravity, vacuum, solar radiation, attitude correction and maneuvering perturbations and with the interface of space plasma. Performance would be evaluated for efficiency of waste heat rejection, response, temperature distribution controllability, flow rate, potential of loss of working fluid and space station contamination due to vaporization and manuevering and effect of space plasma interface on liquid droplet streams trajectory. Zero-gravity effects on droplet generation, trajectory and collection efficiency would be determined. Constraint on operation control and performance will be determined. Performance, failure modes, and lifetime potential will be evaluated using operational data to correlate space and ground test data. Mission would require evaluation under startup, shutdown, full and part load operation. A typical system configuration is shown on figure 1.

III. Benefits

Technology verification/demonstration of advanced radiator system less that 1/4 of the weight of flat plate, tube-fin and hear-pipe radiator designs. Radiator concept does not require surface coatings or armor-plate protection. Radiating area is impervious to micro meteroid damage. Liquid droplet radiator is suitable for low temperature (300K) and high temperature (1000K) NASA and DOD applications in KW and MW range. System is deployable, offers compact stowed configuration and can be designed to survive launch environment.

IV. Justification

Evaluation/technical verification of a radiator for space

application requires sustained operation for a long duration under actual spacecraft operating conditions and space environment of zero-G, solar radiation, vacuum, space plasma and the spacecraft steady state, thermal and manuevering operating modes.

Ground testing lacks sustained zero-G, space plasma and solar radiation availability and does not adequately simulate structual forces or manuevering modes. Shuttle mission objectives, limited mission duration and mission priorities preclude its use for sustained long duration testing and may also limit the size of the experiment.

V. Misson Requirements and Capabilities

A) Orbital Parameters - No constraints. Would operate at space station altitude.

B) Mass, Volume, Operational Envelope - TBD. The test radiator systems should be of specific size, compatible with the space station to provide design/operational data that can be used for scaling to a larger system.

C) Power - Ac-DC continuous electric power would be required for pumping and controls. Other interface requirements are TBD. Magnitude of power requirements are dependent on the size of the experiment.

D) Thermal Control - The equipment could be designed for rejection of a portion of spacecraft heat load. It is unlikely that thermal control provisions would be required for any of itx components except instrumentation.

E) Attitude, Stabilization - The system would be designed to operate within the attitude and stabilization constraints of the space station. Position control of the liquid droplet steam collector may be required. It is anticipated that this would be effected through motorized control.. Method is TBD.

F) Viewing - TBD

G) Environmental Constraints - TBD

H) Data Management, Communication - Experiment control is required to initiate operation, terminate operation and change operating level per waste heat rejection demands. Data acquisition is required for operational control and evaluation.

I) Crew Timeline - TBD. Crew resources may be needed for conduct of experiment at scheduled times.

J) Operations Schedule, Maintenance, Lifetime - No maintenance is planned. Schedule and lifetime are experiment specific and are TBD.

K) Economic or Performance Benefits Achieved Through Use of a Space Station - A space radiator system is operation with power production for long durations. The use of a space station for evaluation of this concept offers the potential of long term testing (not available with shuttle) needed for scaling.

L) Space Station VS Free Flying Platform - TBD.

PAYLOAD ELEMENT NAME Advanced Control Device

CODE G D C D 2 5 0 2

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1994
No. of flights 1
Duration of Flight, days 730

OBJECTIVE Evaluate momentum storage control devices (e.g., third generation control moment gyros and second generation magnetically suspended momentum rings) required by advanced Space Station configurations.

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number 15
(see Table A)

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 5

DESCRIPTION Advanced control devices will be provided as selectable alternatives to operational control devices. Various advanced devices will be evaluated with the operational system serving as a backup. Testing will be performed on a large multibody, flexible structure which could be the same one deployed as payload GDCD 2005.

CODE G D C D 2 5 0 2

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg Any Tolerance + -
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required,m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy,arc sec ____ Field of view, deg ____
Pointing Stability (Jitter)arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☒ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	1000	
Standby	0	
Peak	1000	

☐ Continuous

Voltage,V ____ Frequency,Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) 1 Downlink Frequency (MHZ) ____

CODE GDCD2502

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 100 W,m 20 H,m 2.5 Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 400

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2

Task Assignment Evaluate Control Approach

Skills (See Table B)

SKILL		5	1			
LEVEL		2	2			
Hrs/Day		0.1	0.1			

EVA ☒ YES ☐ NO Reason Assembly/Reconfig/Remove Hrs/EVA 36

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day 360 Man/Hrs Req. 12

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Weight is for control device only (does not include structure from GDCD 2005). Size includes structure.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 2502 ELEMENT NAME ADVANCED CONTROL DEVICE

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1992 INT. HRS ____ EVA HRS 12 EVA CREW 2

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

0.2 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 360 DAYS TOTAL RECONFIGS. 1

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☐ NOT APPLICABLE EVA HRS PER RECONFIG. 12

EVA CREW SIZE 2

5. DEACTIVATION/REMOVAL

DATE(S) 1994 INT. HRS. ____ EVA HRS 12 EVA CREW 2

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Assembly and attachment
3. Monitoring and recording

5. Removal and repackaging

TOTAL EVA HRS 36

Code: GDCD 2502

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Advanced Control Device

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hq., 14-15 September 1982.

Narrative:

Payload element objective, description, accommodation mode, and relationship to large structural payload element (GDCD 2005) taken from Ref 1.

All other data derived.

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title:
Spacecraft Control Technology Development

Langley Contact:
C. R. Keckler

Experiment Title:
Advanced Control Device Technology Demonstration

Mission Objectives:
Evaluate momentum storage control devices (e.g., third generation control moment gyros (CMG's), second generation magnetically suspended momentum rings (AMCD's)) required by advanced space station configurations.

Mission Description:
Advanced control devices will be provided as selectable alternatives to operational control devices. Various advanced devices will be evaluated with the operational system serving as a backup.

Benefit:
Control device technology must continue to evolve as space stations become more complex. Advanced devices can be qualified in space using the operational system to insure safety.

Justification:
Technology supports space station evolution and therefore requires the space station environment for realistic dynamic testing and long duration life testing.

Mission Requirements and Capability:
Essentially the same as the operational control devices. Expanded software is anticipated for the dual hardware interfaces.

Space Station vs. Free Flyer:
Validation on the vehicle of intended application is desirable. Life testing could be accomplished on a free flyer; dynamic control testing must be performed on a large, multibody, flexible structure.

PAYLOAD ELEMENT NAME
Space Component Lifetime

CODE G D C D 2 5 0 3

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1990
No. of flights 1
Duration of Flight, days 3650+

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 15

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 8

OBJECTIVE

To provide a technology base for the development of diverse hardware components for which a multi-year operational lifetime under space conditions is specified.

DESCRIPTION

The proposed mission would characterize the performance lifetime of critical components selected from varied space technologies. Components requiring evaluation in the space environment include primary propulsion systems; solar cell and chemical battery power units; space qualified solid film lubricants; laser and conventional spin gyros; and microwave amplifier cathodes.

CODE G D C D 2 5 0 3

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ____ - ____
Inclination, deg Any ____ Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	____	____
Standby	____	____
Peak	____	____

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE G D C D 2 5 0 3

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 0.2 W,m 0.2 H,m 0.2 Stowed
L,m 0.2 W,m 0.2 H,m 0.2 Deployed

Launch mass, kg 300

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1

Skills (See Table B)

Task Assignment: Evaluate Critical Component Performance

SKILL	1					
LEVEL	2					
Hrs/Day	0.2					

EVA ☒ YES ☐ NO Reason Configuration Change Hrs/EVA 152

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day 180 Man/Hrs Req. 8
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Size is unit size for each of six components. Weight is for six representative components.

GDCD CODE 2503 ELEMENT NAME SPACE COMPONENT LIFETIME

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1990 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

.2 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL 180 DAYS TOTAL RECONFIGS. 19

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☐ NOT APPLICABLE EVA HRS PER RECONFIG. 8

EVA CREW SIZE 1

5. DEACTIVATION/REMOVAL

DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Set up part of station OPS
3. Monitoring and recording
4. 2 EVA's per year over 10 year period
5. Set-up/removal part of configuration charge

TOTAL EVA HRS 152

Code: GDCD 2503

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Space Component Lifetime Technology

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hq., 14-15 September 1982.

Narrative:

Payload element objective, description, accommodation mode, and duration taken from Ref 1.

Number of components and all other data derived.

SPACE COMPONENT LIFETIME TECHNOLOGY

I. Mission Objective

To provide a technology base for the development of diverse hardware components for which a multi-year operational lifetime under space conditions is specified.

II. Mission Description

The propsed mission would characterise the performance lifetime of critical components selected form varied space technologies. Components requiring evaluation in the space environment include primary propulsion systems; solar cell and chemical battery power units; space qualified solid film lubricants; laser and conventional spin gyros; and microwave amplifier cathodes.

III. Benefit

The proposed technology evaluation of spaceborne power units, propulsion systems, and navigational devices will have direct applicability to NASA deep planetary missions. In general, the component lifetime demonstrations achieved through the proposed Mission would increase the probability for sucess of advanced space projects.

IV. Justification

It is clear from the definition of the Mission objectives that the requiste component technology investigation can only occur on a long duration space laboratory. For proper solar cell technology evaluation, both the orbital solar illumination and high energy particle flux are required. In additon to conversion efficiency, a major technological tradeoff between silicon and gallium arsnide solar cells is the ability to withstand radiation damage. In order to perform the in situ annealing and repair of degraded solar cells, a manned presence is required.

V. Mission Requirements and Capabilities

A) Orbital Parameters- The Mission orbit should insure the requisite photon and high energy particle flux.

B) Mass, Volume, and Operational Envelope- TBD

C) Power- Instrument specfic.

D) Thermal Control- TBD

E) Attitude, Stabilization- Verification and measurement of

gryoscopic performance requires high space station angular stability.

F) Viewing - See comment A) above.

G) Environmental Constraints- none.

H,I) Data Management, Communications, Crew Lifetime- TBD

J) Operations Schedule, Maintenance, Lifetime- The components to be tested have nominal space lifetimes between five and ten years.

VI. Space Station vs. Free Flyer

Although a detailed trade-off analysis is required it should be pointed out that the critical Mission specifications are characteristic of anticipated space station performance.

PAYLOAD ELEMENT NAME
OTV Payload Handling

CODE G D C D 2 5 0 4

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1992
No. of flights 1
Duration of Flight, days 30

OBJECTIVE

To develop procedures, software, and hardware for maneuvering payloads at the Space Staion and interfacing with OTV/TMS systems, in order to be ready for actual missions to follow.

TYPE
- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 15

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 9

DESCRIPTION Sample or mocked-up payloads with planned interfaces will be delivered to the orbiting Space Statioan by the Shuttle. Typical maneuvers such as berthing at the station mating to an OTV, and deploying in orbit, will be performed. EVA and RMS/TMS operations will both be investigated. Information from the experiments will be fed back into the design process, impacting the configuration of interfaces and handling equipment.

CODE
GDCD2504

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg Any Tolerance + -
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	300	2
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☒ Digital ☒ Hrs/Day 2
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) 4 Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

ORIGINAL PAGE IS
OF POOR QUALITY

CODE G D C D 2 5 0 4

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 4 W,m 4.5 H,m 4.5 Stowed
L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 2000

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2

Skills (See Table B) Task Assignment ______

SKILL	7	7				
LEVEL	3	2				
Hrs/Day	4	4				

EVA ☒ YES ☐ NO Reason Payload Handling Hrs/EVA 60

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

EVA is part of payload element operation. 2 Hr/Day.

GDCD CODE 2504 ELEMENT NAME OTV PAYLOAD HANDLING

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1992 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

3 HRS PER DAY (INTERNAL) for 30 days

2 HRS PER DAY (EVA) for 30 days

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) 1992 INT. HRS. ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Original set up part of station operations
3. Inside/outside activity for 30 day period
5. Removal part of station operation

TOTAL EVA HRS 60

Code: GDCD 2504

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: OTV Payload Handling

Reference Documents:

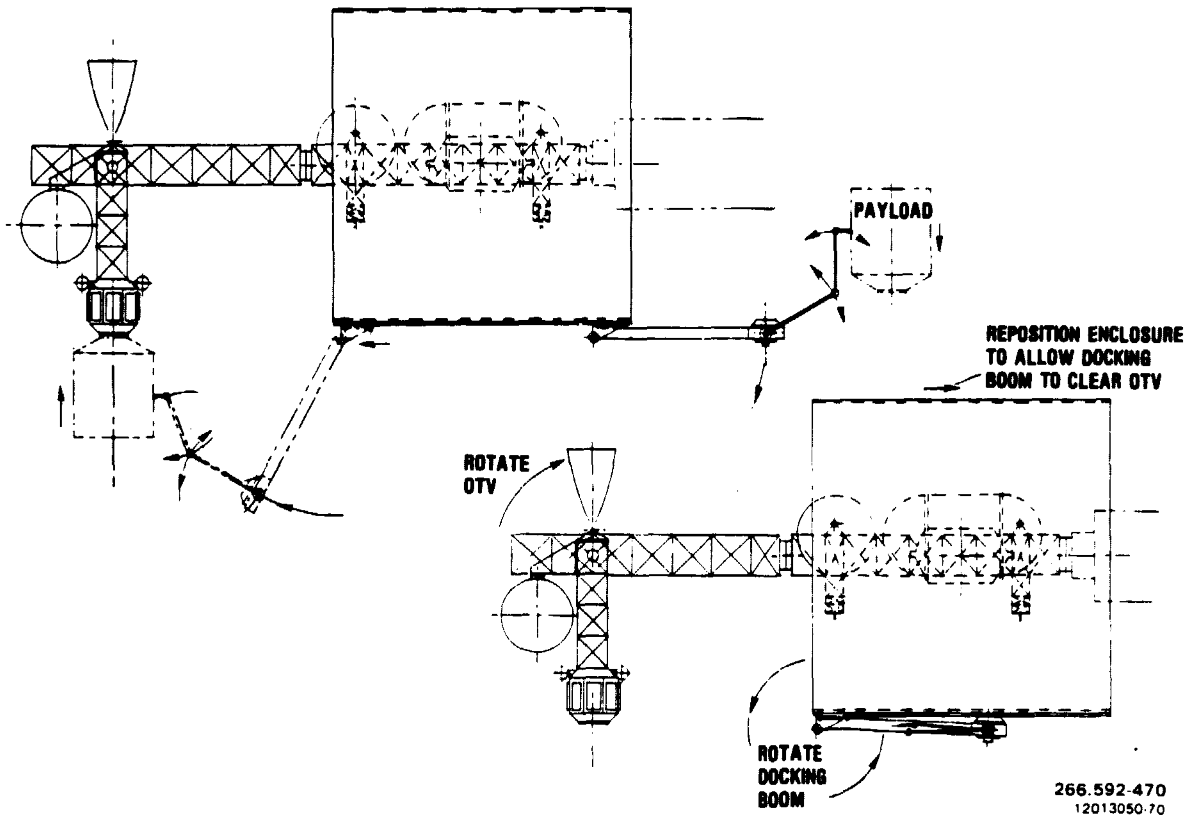
1. Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hq., 14-15 September 1982.

2. Definition of Technology Development Mission for Early Space Station, Orbit Transfer Vehicle Servicing, General Dynamics Convair Division, NAS 8-35039.

Narrative:

This payload element is based in part on Ref 1 entitled "OTV Servicing Technology", and on data developed in Ref 2.

The service enclosure is equipped with a docking boom that contains a motorized carriage at one end and a RMS at the opposite end. Prior to attaching the payload, the service enclosure is moved toward the Space Station and the simulated OTV is rotated 90 degrees. The simulated payload is retrieved from the Space Station holding fixture by moving the docking boom along the length of the service enclosure and attaching the docking boom RMS to the payload. The simulated payload is then mated to the OTV using the dock boom and RMS.



.OTV/Payload Operations TDM

PAYLOAD ELEMENT NAME
Payload Servicing and Repair

CODE
G D C D 2 5 0 5

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1992
No. of flights 1
Duration of Flight, days 90

OBJECTIVE
To develop procedures, software, and hardware for servicing payloads in orbit, in order to be ready to perform this function on an operational basis.

TYPE
- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 15

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 9

DESCRIPTION
A sample "servicing module" comprising typical preproduction electrical panels, fluid connections, latching devices, couplings, and other interfaces associated with servicing functions will be deployed externally at the station. Astronauts will utilize this equipment to perform simulated service/repair/reconfiguration functions in the space environment. Information feedback will influence the design of pertinent equipment.

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CODE G D C D 2 5 0 5

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ____ - ____
Inclination, deg Any ____ Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating		
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) 4 Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

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CODE G D C D 2 5 0 5

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 3 W,m 4.5 H,m 4.5 Stowed
L,m 9 W,m 4.5 H,m 4.5 Deployed

Launch mass, kg 500

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1

Skills (See Table B) Task Assignment

SKILL	7					
LEVEL	3					
Hrs/Day	1					

EVA ☒ YES ☐ NO Reason Payload Operations Hrs/EVA 200

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

EVA is required for payload element operations 2.2 Hr/Day.

GDCD CODE 2505 ELEMENT NAME PAYLOAD SERVICING AND REPAIR

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1992 INT. HRS ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ______ DAYS TOTAL SERVICES ______

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

1 HRS PER DAY (INTERNAL) for 90 days

2.2 HRS PER DAY (EVA) for 90 days (200 total)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) 1992 INT. HRS. ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Original set ups part of station operations
3. Inside/outside activity for 90 day period
5. Removal part of station operations

TOTAL EVA HRS 200

Code: GDCD 2505

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Playload Servicing and Repair

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hq, 14-15 September 1982

2. Definition Of Technology Development Mission For Early Space Station, Orbit Transfer Vehicle Servicing, General Dynamics Convair Division, NAS 8-35-39

Narrative:

This payload element is based in part on Ref 1 entitled ""Satellite Servicing Technology", and on data derived in Ref 2.

PAYLOAD ELEMENT NAME
Propellant Transfer and Storage

CODE G D C D 2 5 0 6

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1991
No. of flights 1
Duration of Flight, days 30

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 15

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 9

OBJECTIVE

To develop procedures and hardware for transfering and gauging OTV cryogenic propellants on orbit and for their long duration storage.

DESCRIPTION A storage and receiver tank will be delivered to the Space Station by the Shuttle. For propellant transfer, investigations will be performed in the areas of fluid interface connections, childown of transfer lines and receiver tank, and propellant transfer. For long duration storage, investigations will be performed in the areas of propellant condition/quantity/monitoring, insulation, meteoroid protection, propellant acquisition, stratification/pressurization, and venting.

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CODE G D C D 2 5 0 6

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg Any Tolerance + -
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☒ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	300 - 500	2
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☒ Digital ☒ Hrs/Day 2
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other ____
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

CODE GDCD2506

THERMAL
☐ Active ☐ Passive
Temperature, deg C operational min ____ max ____
non-operational min ____ max ____
Heat Rejection, w operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS
Location: ☐ Internal ☒ External ☐ Remote
Equipment ID/Function ☐ Pressurized ☒ Unpressurized
L,m ____ W,m ____ H,m ____ Stowed
L,m 8.5 W,m 4.6 H,m 3.6 Deployed
Launch mass, kg 2000
Consumables Types LH_2
Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS
Crew Size 1
Skills (See Table B) Task Assignment ____

SKILL	7					
LEVEL	3					
Hrs/Day	1					

EVA ☐ YES ☒ NO Reason ____ Hrs/EVA ____

SERVICING/MAINTENANCE
SERVICE: Interval, days ____ Consumables, kg ____
Returnables, kg ____ Man Hours ____
CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____
Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions
Interface/attach points for tank support beams and power/data interface.

GDCD CODE 2506 ELEMENT NAME OTV PROPELLANT TRANSFER AND STORAGE

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1991 INT. HRS ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ______ DAYS TOTAL SERVICES ______

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

1 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) 1991 INT. HRS. ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. are considered station operations
3. This is a 30 day mission

TOTAL EVA HRS 0

Code: GDCD 2506

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: OTV Propellant Transfer and Storage

Reference Documents:

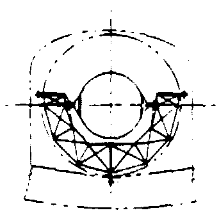
1. Technology Development Mission, Space Station NAAO Study Orientation Meeting, NASA Hq., 14-15 September 1982

2. Definition of Technology Development Missions for Early Space Station, Orbit Transfer Vehicle Servicing, General Dynamics Convair Division, NAS 8-35039

Narrative:

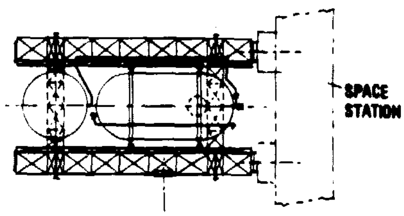
This payload element is based in part on Ref 1 entitled OTV Servicing Technology and on data developed in Ref 2.

The propellant transfer module consists of one spherical receiver tank, one cylindrical supply tank with spherical bulkheads, an open truss support structure, transfer lines, shuttle interface plumbing (fill, drain, vent, dump), and a helium supply system for dump and transfer. Each tank has an acquisition system and multi-layer insulation. Both tanks are supported from the truss structure which in turn interfaces with the Shuttle longeron and keel fittings. The support truss also has berthing systems on the forward and aft ends and on one side. The aft end attaches to the space station, the forward end attaches to beams delivered on a subsequent flight and the side interfaces with the propellant conservation (liquefaction) module. The transfer module also includes data control and interface electronics and a hydrazine system for filling and discharging the ACS bottles.

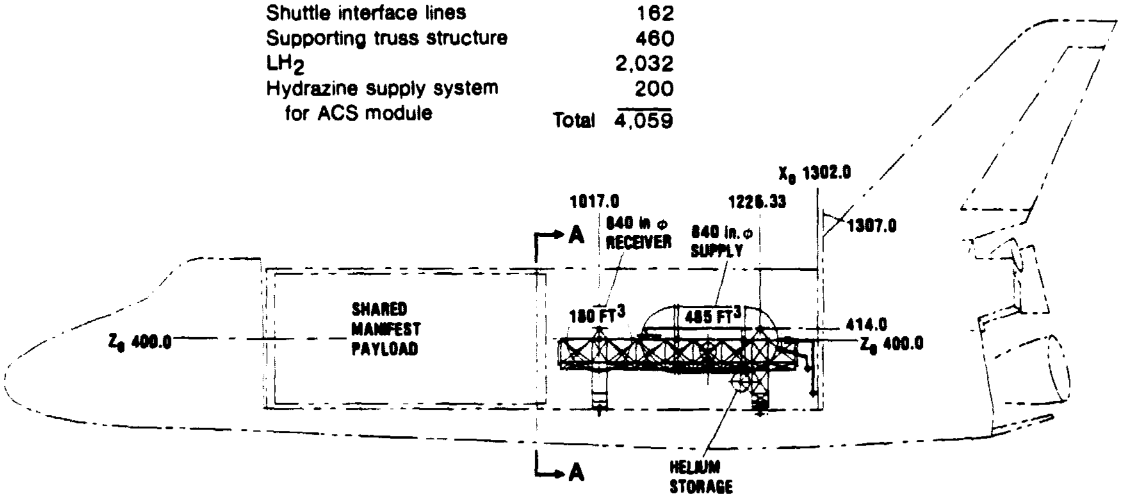


A-A

Equipment	Wt (lb)
Receiver tank	95
Receiver tank acquisition system	65
Receiver tank MLI	25
Supply tank	170
Supply tank acquisition system	130
Supply tank MLI	108
Transfer lines	182
Data control & interface electronics	250
Helium storage	180
Shuttle interface lines	162
Supporting truss structure	460
LH_2	2,032
Hydrazine supply system for ACS module	200
Total	4,059



DOCKED TO SPACE STATION



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Propellant Transfer & Storage TDM

PAYLOAD ELEMENT NAME
OTV Propellant Liquefaction

CODE G D C D 2 5 0 7

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1991
No. of flights 1
Duration of Flight, days 30

OBJECTIVE

To develop procedures and hardware to reliquify cryogenic propellant boil-off from long duration storage tanks.

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 15

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 9

DESCRIPTION Either a Sterling or Brayton Cycle refrigeration system will be delivered to the Space Station by the Shuttle. This system will be attached to the long term storage tanks and investigations carried out in reliquifying the boil-off propellant from the storage tanks. The efficiency of the system propellant quantity reliquified, power required, and reliability of the system will be investigated.

CODE
G D C 0 2 5 0 7

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ___ - ___
Inclination, deg Any Tolerance + ___ - ___
Nodal Angle, deg ___ Ephemeris Accuracy, m ___
Escape dV Required, m/s ___

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ___
Pointing accuracy, arc sec ___ Field of view, deg ___
Pointing Stability (Jitter) arc sec/sec ___
Special Restrictions (Avoidance) ___

POWER

☒ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	350	
Standby		
Peak		

☒ Continuous

Voltage, V ___ Frequency, Hz ___

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ___
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ___ Frequency (MHZ) ___
☐ On-Board Data Processing Required
Description ___

Data Types: ☐ Analog ☒ Digital ☒ Hrs/Day 1
Film (Amount) ___ Voice (Hrs/Day) ___
Live TV (Hrs/Day) ___ Other ___
On-Board Storage (MBIT) ___
Data Dump Frequency (Per Orbit) ___
Recording Rate (KBPS) ___ Downlink Frequency (MHZ) ___

CODE G D C D 2 5 0 7

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed
L,m 3.5 W,m 2.0 H,m 2.0 Deployed

Launch mass, kg 1000

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1 Task Assignment ______

Skills (See Table B)

SKILL	7					
LEVEL	3					
Hrs/Day	1					

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Power and data interface.

GDCD CODE 2507 ELEMENT NAME OTV PROPELLANT LIQUEFACTION

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1991 INT. HRS ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ____ DAYS TOTAL SERVICES ____

   ☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

   ☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

   EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   1 HRS PER DAY (INTERNAL)

   ____ HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ____ DAYS TOTAL RECONFIGS. ____

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

   EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

   DATE(S) 1991 INT. HRS. ____ EVA HRS ____ EVA CREW ____

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. are considered station operations
3. This is a 30 day mission.

TOTAL EVA HRS 0

Code: GDCD 2507

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: OTV Propellant Liquefaction

Reference Documents:

1. Technology Development Mission, Space Station NAAO Study Orientation Meeting, NASA Hq., 14-15 September 1982

2. Definition of Technology Development Missions for Early Space Station, Orbit Transfer Vehicle Servicing, General Dynamics Convair Division, NAS 8-35039

3. Investigation of Gas Liquefiers For Space Operation, AF Aero-Propulsion Laboratory Aeronautical Syst. Div., Airforce Syst. Command Wright - Patterson AFB, Ohio. Prepared by Malaker Lab. Inc. High Bridge, N.J., J.G. Daunt et al. 1968

4. Handbook of External Refrigeration Syst. for Long Term Aero Storage, LMSC Sunnyvale, CA 1971.

Narrative:

This payload element is based in part on Ref 1 entitled OTV Servicing Technology and on data developed in Ref 2. Refrigeration requirements are derived based on Ref 3 and 4.

The propellant liquefaction module is a multi-sided box-type package containing refrigeration equipment, electrical systems, instrumentation, controls, and disconnect systems for attaching to the transfer module. The module also has a radiator package strapped on the aft end, which is attached to the Space Station structure. The Space Station incorporates plumbing between the radiator attachment and the transfer module.

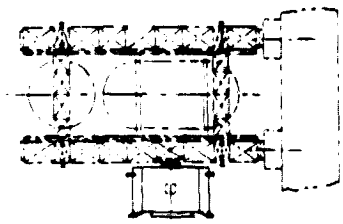
The propellant liquefaction module is supported from a truss cradle that in turn interfaces with the Shuttle keel and longeron fittings. The module is located at the forward end of the shuttle payload bay, which is within the reach envelope of the shuttle RMS.

ORIGINAL PAGE IS
OF POOR QUALITY

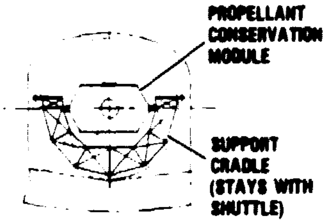
Code: GDCD 2507

PAYLOAD ELEMENT SYNTHESIS

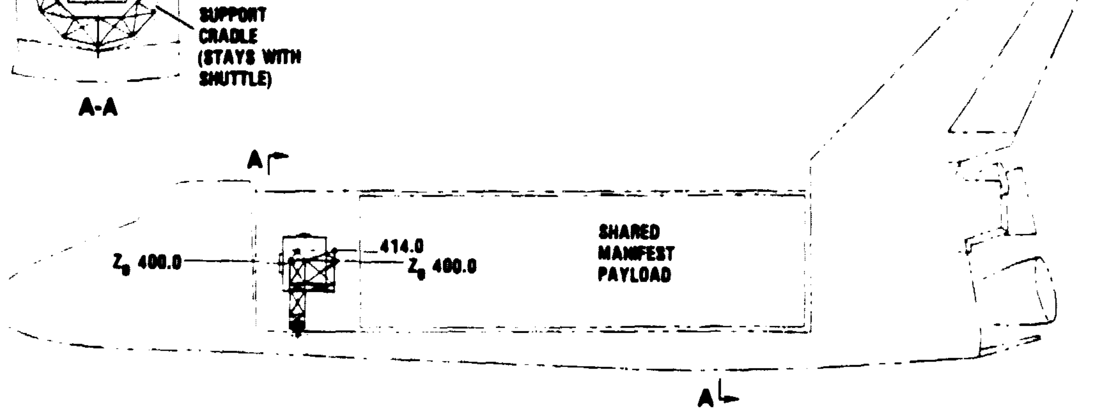
Equipment	Wt (lb)
Support cradle (stays with shuttle)	500
Module body structure	200
Disconnect systems	105
Berthing system	190
Electrical systems	150
Refrigeration equipment	600
Instrumentation & controls	250
Radiators	450
Total	2,445



PROPELLANT CONSERVATION MODULE DOCKED TO TRANSFER MODULE



A-A



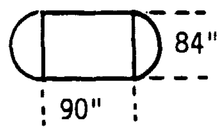
Shuttle cost = $10.5M

12013050-61
266.592-472

Propellant Reliquefaction TDM

Space Heater Transfer To The Supply And Receiver Tanks

SUPPLY TANK



VOLUME: 485 ft^3

WEIGHT OF LH_2 (5% ULLAGE): 2027 LB

SURFACE:

Surface of sphere $= 4\pi r^2 - 4\pi\ 3.5^2 = 153.86\ ft^2$

Surface of straight section $= D\pi L =$ $\underline{164.85}$

$318.71\ ft^2$

HEAT LEAK $\dfrac{0.16\ BTU\ 318.71\ ft^2}{hr\ ft^2} = 51.0\ \dfrac{BTU}{hr}$

HEAT FLUX $= 0.16\ \dfrac{BTU}{hr}$ From experimental results using the 87" tank

BOIL OFF RATE $= \dfrac{51\ BTU}{hr}\ \dfrac{lb}{192\ BTU} = 0.27\ \dfrac{lb}{hr} = 6.48\ \dfrac{lb}{day}$

LAYERS OF MLI = 45 Radiation Shields

RECEIVER TANK

VOLUME: 180 ft^3

WEIGHT OF LH_2 (5% ULLAGE): 752 lb

SURFACE: 153.86 ft^2

HEAT LEAK: $(0.16)\ 153.86 = 24.6\ \dfrac{BTU}{hr}$

BOIL OFF: $\dfrac{24.6}{192} = 013\ \dfrac{lb}{hr} = 3.12\ \dfrac{lb}{day}$

Refrigeration Requirements
(Stirling or Brayton Cycle)

WATTS OF REFRIGERATION NEEDED FOR RELIQUEFACTION OF 1 LB/DAY OF HYDROGEN = 2.37 WATTS (Ref 3).

COOLING NEEDED TO RELIQUEFY THE BOILOFF FROM THE SUPPLY & RECEIVER TANK:

0.27 lb/hr + 0.13 lb/hr = 0.40 lb/hr = 9.6 lb/day

THE COOLING NEEDED TO RELIQUEFY 0.4 lb/hr:

$$(9.6 \text{ lb/day})\ 2.37 \frac{\text{W}}{\text{lb/day}} = 22.75\text{W}$$

RELIQUEFICATION RATE IS $\frac{22.75\text{W-hr}}{0.4 \text{ lb}} = 56.88 \frac{\text{W-hr}}{\text{lb}}$

NOMINAL COOLING DESIRED:

SUPPLY TANK + RECEIVER TANK

$$51.0 \frac{\text{BTU}}{\text{hr}} + 24.6 \frac{\text{BTU}}{\text{hr}} = \frac{\text{BTU}}{\text{lb}}$$

IN WATTS = 75.6 x 0.2930 = 24W

DESIGN COOLING 10% MARGIN = 22W

NOMINAL COOLING TEMP. 20K

COOLING RANGE 17-23K

COEF OF PERFORMANCE COP $= \frac{\text{Q REFR.}}{\text{Q INPUT}} = \frac{T_c}{T_h - T_c}$ carnot

ASSUME MAX TEMP T_h = 300K
T_c = 20K

$$\text{COP} = \frac{20}{300-20} = 0.071$$

THE POWER INPUT FOR RELIQUEFACTION $= \frac{24}{0.071} = 338\text{W}$

SPEC. WEIGHT = 2 LB/WATT (Ref 4)
TOTAL REFR. WEIGHT = 676 lb
SPEC. VOLUME: 70 m^3/WATT
REFRIG. VOLUME: 23660 in^3/WATT = 13.7 ft^3
WASTE HEAT RADIATOR: $\approx$ 200 ft^3
POWER SUPPLY: PHOTOVOLTAIC AREA ON SPACE STATION OR ERECTABLE PANEL TYPE CONFIGURATION

COOL DOWN OF THE REFRIGERATOR

Cool down time of a refrigerator, where the mass is relatively high and where intermittent operation is desirable, can be an important consideration. For the intermittant operation case all heat exchanger elements and fluid cooling systems must be cooled down to operating conditions prior to efficient propellant refrigeration.

COEFFICIENT OF PERFORMANCE (COP)

1. The COP decreases substantially as the unit becomes smaller - higher heat leaks, components more difficult to fabricate - unfavorable area to volume ratios - fictional losses higher.

2. The COP is so low because there are so many components involved - heat - source - heat sink, mechanical refrigeration and mechanical work source. Refrigerater has a compressor, expander, and motor. These components contribute to the COP.

PAYLOAD ELEMENT NAME
OTV Docking and Berthing

CODE G D C D 2 5 0 8

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1991
No. of flights 1
Duration of Flight, days 30

OBJECTIVE

To develop procedures, software and hardware for docking and berthing an OTV to a Space Station.

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number 15
(see Table A)

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 9

DESCRIPTION Deliver a modified TMS, a simulated OTV and docking, berthing and maintenance equipment to the Space Station by means of the Shuttle. Perform docking operations with a modified TMS and docking mechanisms to simulate OTV characteristics in the areas of stability and control, maneuverability, communications, connecting up, and monitoring and controls. Perform berthing system operations to verify equipment and procedures in the areas of alignment sensors, contact sensors, coupling and access, and manipulators. Automated docking and berthing capability with manned backup should be investigated and verified.

CODE G D C D 2 5 0 8

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ___ -
Inclination, deg Any Tolerance + ___ -
Nodal Angle, deg ___ Ephemeris Accuracy, m ___
Escape dV Required, m/s ___

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ___
Pointing accuracy, arc sec ___ Field of view, deg ___
Pointing Stability (Jitter) arc sec/sec ___
Special Restrictions (Avoidance) ___

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	300 - 500	2
Standby		
Peak		

☐ Continuous

Voltage, V ___ Frequency, Hz ___

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☒ Realtime ☐ Offline ☐ Other ___
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ___ Frequency (MHZ) ___
☐ On-Board Data Processing Required
Description ___

Data Types: ☐ Analog ☒ Digital ☒ Hrs/Day 2
Film (Amount) ___ Voice (Hrs/Day) ___
Live TV (Hrs/Day) 2 Other ___
On-Board Storage (MBIT) ___
Data Dump Frequency (Per Orbit) ___
Recording Rate (KBPS) ___ Downlink Frequency (MHZ) ___

CODE G D C D 2 5 0 8

THERMAL

☐ Active ☐ Passive

Temperature, deg C — operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w — operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ______ W,m ______ H,m ______ Stowed

L,m 10.0 W,m 4.5 H,m 4.5 Deployed

Launch mass, kg 5900

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1 Task Assignment ______

Skills (See Table B)

SKILL	7					
LEVEL	3					
Hrs/Day	2					

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Power and data interface. Control station for docking. Docking and berthing for TMS when not used as simulated OTV.

GDCD CODE 2508 ELEMENT NAME OTV DOCKING AND BERTHING

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1991 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

2 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) 1991 INT. HRS. ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. are considered station operations.
3. This is a 30 day mission

TOTAL EVA HRS 0

Code: GDCD 2508

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: OTV Docking & Berthing

Reference Documents:

1. Technology Development Mission, Space Station NAAO Study Orientation Meeting, NASA Hq., 14-15 September 1982

2. Definition of Technology Development Missions for Early Space Station, Orbit Transfer, Vehicle Servicing, General Dynamics Convair Division, NAS 8-35039

Narrative:

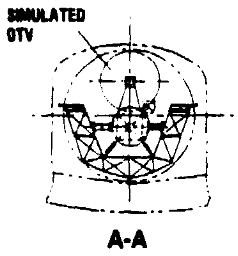
This payload element is based in part on Ref 1 entitled OTV Servicing Technology and data developed in Ref 2.

The simulated OTV and two truss frames are supported in the Shuttle payload bay. The OTV is attached to the two truss frames by means of berthing arms and the entire package (frames & OTV) is deployed from the shuttle and attached to the propellant transfer module. The truss frames also have an open "cherry picker" type device mounted on powered carriages for retraining the astronauts.

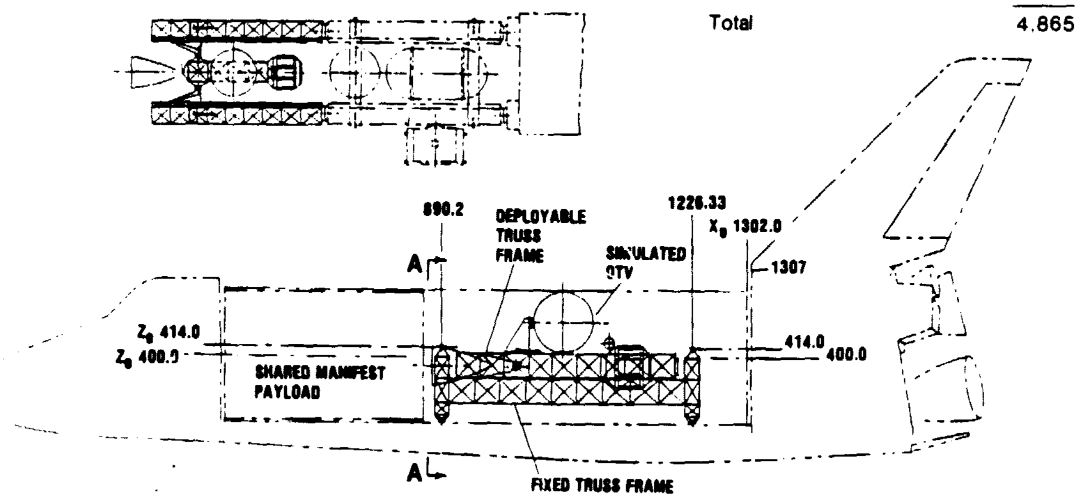
The modules shown can be removed from the simulated OTV for maintenance Technology Development Mission. The berthing interface is at the aft end of the core module.

The module sizes were selected to be representative of actual sizes for an OTV in order to develop the capability to handle this type of equipment in space.

The berthing enclosure is positioned at the end of the truss beams away from the space station and the docking boom is rotated 90 degrees to the berthing enclosure. This provides a docking target removed from adjacent structures. Docking tests are performed using a TMS equipped with an adapter. The simulated OTV is positioned in the berthing port and will be used for the berthing tests.



Equipment	Wt (lb)
Support cradle (stays with Shuttle)	700
Truss beams	600
Docking arm	400
EVA manipulators	400
Holding fixtures (motorized)	415
Disconnect arms	300
Disconnect systems	200
Simulated OTV	1,290
Truss beam berthing systems	380
Electrical & instrumentation	180
Total	4,865



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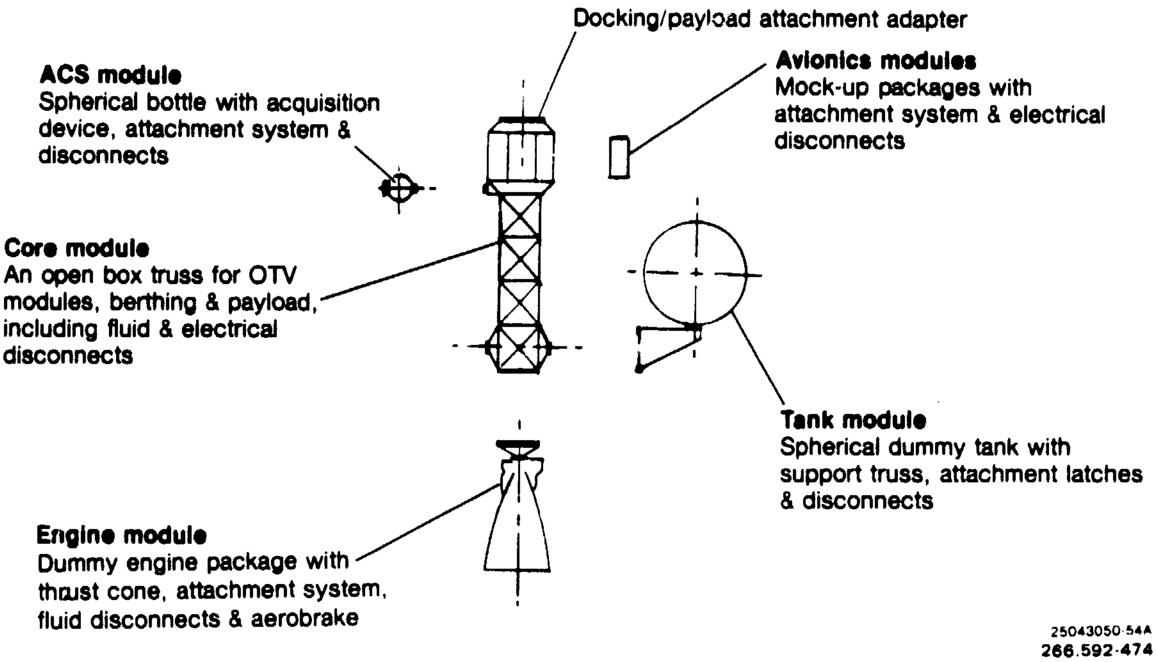
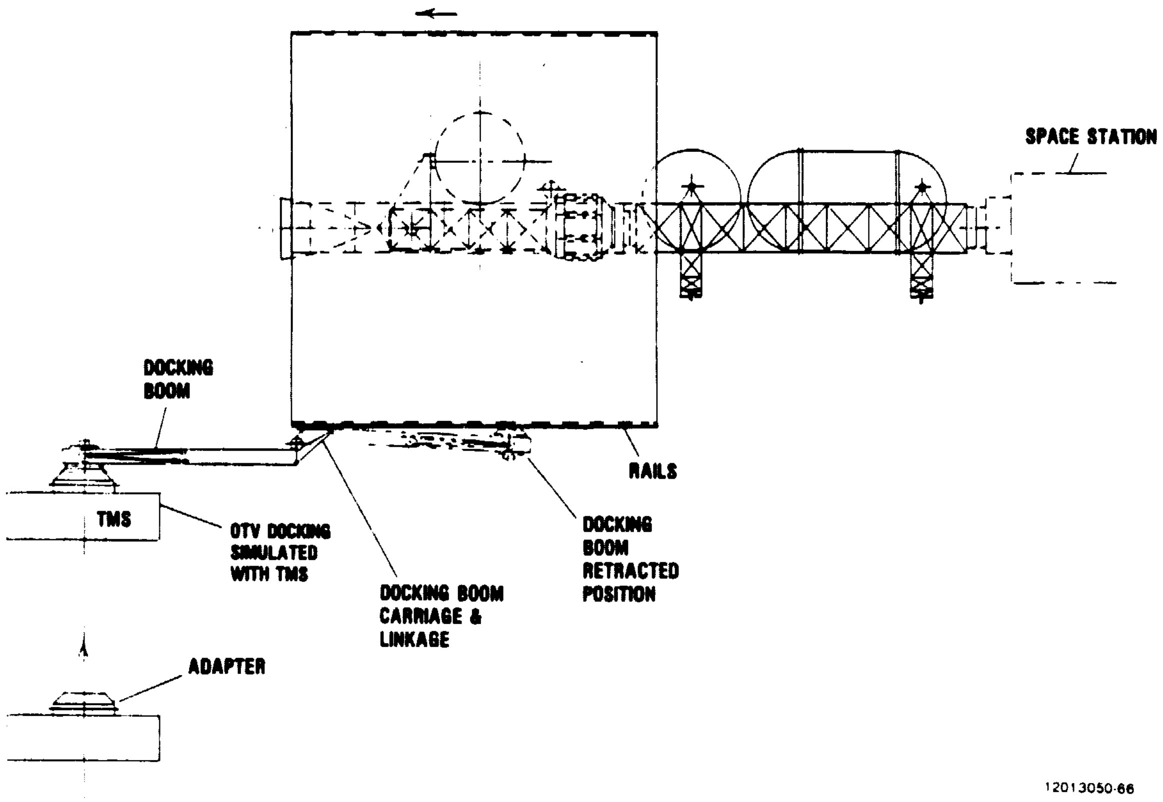
Docking & Berthing Servicing TDM



Simulated OTV



Docking TDM with Modified TMS

PAYLOAD ELEMENT NAME
OTV Maintenance

CODE
G D C D 2 5 0 9

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1992
No. of flights 1
Duration of Flight, days 30

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 15

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 10

OBJECTIVE

To develop procedures, software and hardware for maintaining a space-based OTV on a Space Station. Particular emphasis will be placed on capability of crew to perform EVA tasks and the extent maintenance tasks can be automated.

DESCRIPTION Deliver a simualted OTV along with berthing and maintenance equipment to the Space Station by the Shuttle (this equipment will be at the station if the docking and berthing TDM precedes this one). In addition, deliver a serivce enclosure (collapsed in the cargo bay) with maintenance equipment to the Space Station by the Shuttle. Perform typical maintenance tasks on the simulated OTV to evaluate the capability of the crewmen to perform EVA tasks and the automated equipment to perform remove and replace tasks. The major functions to be investigated are visual inspection, equipment handling, and remove and replace. Remove and replace includes typical avionics equipment, ACS system, power generation system, main engine and propellant tank.

CODE
G D C D 2 5 0 9

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☒ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	300 - 500	4
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☒ Offline ☐ Other ____
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☒ Digital ☒ Hrs/Day 4
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) 4 Other ____
On-Board Storage (MBIT) 200
Data Dump Frequency (Per Orbit) 1
Recording Rate (KBPS) 4 Downlink Frequency (MHZ) ____

CODE 6 D C D 2 5 0 9

THERMAL
☐ Active ☐ Passive
Temperature, deg C operational min ______ max ______
non-operational min ______ max ______
Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS
Location: ☐ Internal ☒ External ☐ Remote
Equipment ID/Function ☐ Pressurized ☒ Unpressurized

				Stowed/Deployed
L,m 8.5	W,m 4.5	H,m 2.0		Stowed
L,m 8.5	W,m 7.5	H,m 7.5		Deployed

Launch mass, kg 3000
Consumables Types ______
Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS
Crew Size 4 Task Assignment ______
Skills (See Table B)

SKILL	7	7	7	7		
LEVEL	3	3	3	3		
Hrs/Day	4	4	4	1		

EVA ☒ YES ☐ NO Reason Mission Operations Hrs/EVA 250

SERVICING/MAINTENANCE
SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______
CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Control consoles. Power and data interface. EVA is 8.33 Hr/Day of mission operations which are development of OTV maintenance capability. Crew size includes EVA personnel.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GOCD CODE 2509 ELEMENT NAME OTV Maintenance

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

   DATE(S) 1992 INT. HRS ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

   INTERVAL ______ DAYS TOTAL SERVICES ______

   ☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

   ☒ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

   EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

   5 HRS PER DAY (INTERNAL)

   8.33 HRS PER DAY (EVA)

   ☐ NOT APPLICABLE

4. RECONFIGURATION

   INTERVAL ______ DAYS TOTAL RECONFIGS. ______

   ☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

   ☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

   EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

   DATE(S) 1992 INT. HRS. ______ EVA HRS ______ EVA CREW ______

   ☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. are considered station operations.
3. This is a 30 day mission; inside/outside operations are engine and tank changeout on simulated OTV development tasks.

TOTAL EVA HRS 250

Code: GDCD 2509

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: OTV Maintenance

Reference Documents:

1. Technology Development Missions, space Station NAAO Study Orientation Meeting, NASA Hq., 14-15 September 1982.

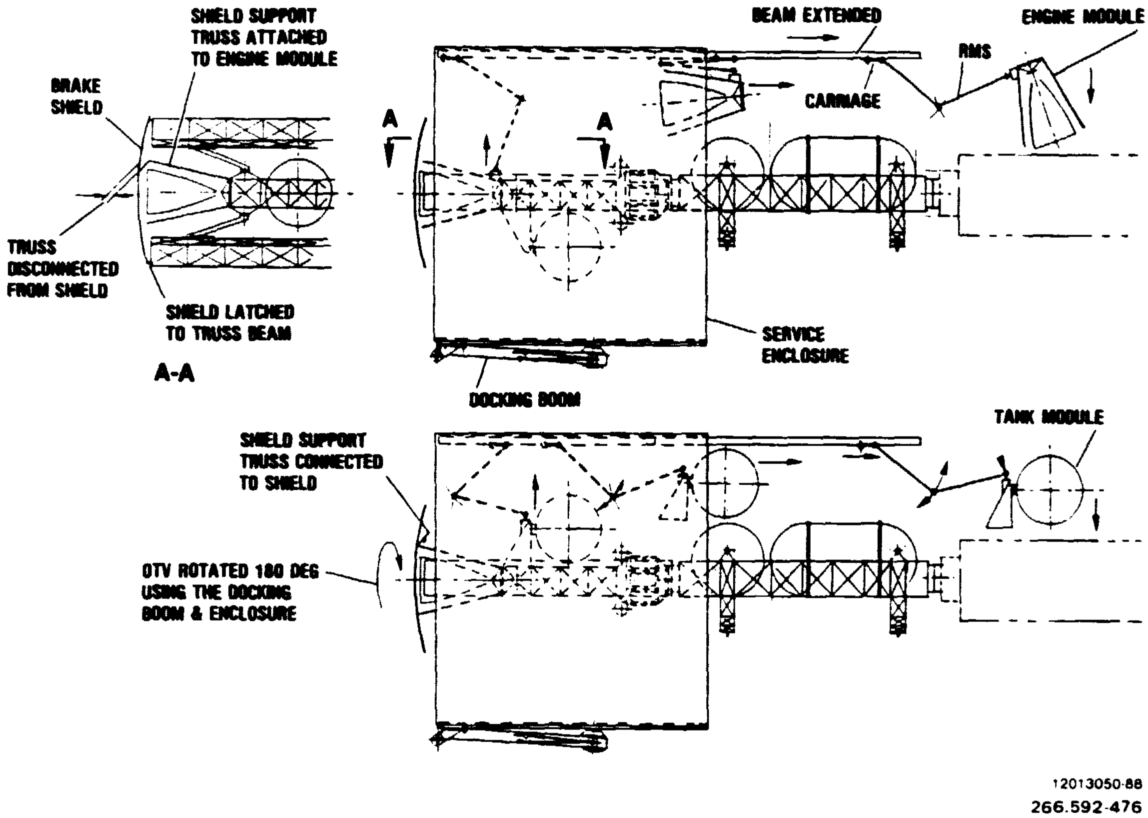
2. Definition of Technology Development Missions for Early Space Station, Orbit Transfer Vehicle Servicing, General Dynamics Convair Division, NAS 8-35039.

Narrative:

This payload element is based in part on Ref 1 entitled OTV Servicing Technology and on data developed in Ref 2.

Two service examples are shown with an aerobrake attached to the simulated OTV. The first example is an engine module changeout. The engine module is equipped with an open truss cage, which attaches to the aerobrake through a series of structural disconnects. The change out is accomplished by latching the aerobrake to the truss beams; (view A-A); attaching the service enclosure RMS to a holding fixture on the space station. The reverse of this procedure is used to install the new engine module.

The second example shows a propellant tank module change out. This requires rotating the OTV 180 degrees so that the tank module is within reach of the RMS. This 180 degree rotation is accomplished using the enclosure and the docking boom.



Maintenance TDM – Engine & Tank Change Out

PAYLOAD ELEMENT NAME
Tether Dynamics Technology

CODE GDCD2510

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1995
No. of flights 1
Duration of Flight, days 3

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 15

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 2

OBJECTIVE

Demonstrate feasibility of tether operations on a small scale before involving Shuttle orbiters and external tanks.

DESCRIPTION

Use two remotely piloted vehicles (RPVs) operated in coordination with a tether cable to demonstrate rendezvous and docking with free end of a tether cable, interchange orbits, spin-up for artificial gravity and raise an elevator from one orbit to another using a tether cable.

CODE G D C D 2 5 1 0

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ____ - ____
Inclination, deg Any Tolerance + ____ - ____
Nodal Angle, deg ____ Ephemeris Accuracy, m ____
Escape dV Required, m/s ____

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ____
Pointing accuracy, arc sec ____ Field of view, deg ____
Pointing Stability (Jitter) arc sec/sec ____
Special Restrictions (Avoidance) ____

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	2000	3
Standby		
Peak		

☐ Continuous

Voltage, V ____ Frequency, Hz ____

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☒ Other TDRSS
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ____ Frequency (MHZ) ____
☐ On-Board Data Processing Required
Description ____

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ____
Film (Amount) ____ Voice (Hrs/Day) ____
Live TV (Hrs/Day) ____ Other TDRSS
On-Board Storage (MBIT) ____
Data Dump Frequency (Per Orbit) ____
Recording Rate (KBPS) ____ Downlink Frequency (MHZ) ____

ORIGINAL PAGE IS
OF POOR QUALITY

CODE G D C D 2 5 1 0

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______
non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 4 W,m 4 H,m 2 Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 3000

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 1

Skills (See Table B) Task Assignment ______

SKILL	5					
LEVEL	2					
Hrs/Day	3					

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Crew operations for launch and retrieval of free-flyer subsatellite and for monitoring tether test.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GDCD CODE 2510 ELEMENT NAME TETHER DYNAMICS TECHNOLOGY

ACCOMODATION: ☒ ATTACHED ☐ FREE FLYER ☐ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1995 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

3 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) 1995 INT. HRS. ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. and 5. Times for activation and deactivation are included in experimental operations

3. Duration of experiment is 3 days for deploy, monitor, control, retrieve subsatellites. Free-flying experimental subsatellites (RPV or TMS) are interconnected on tether cable

TOTAL EVA HRS 0

Code: GDCD 2510 PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Tether Dynamics Technology

Reference Documents:

1. "Utilization of the External Tanks of the Space Transportation System" Draft report (8 Oct. 1982) on a workshop held at the University of California, San Diego, La Jollla, CA, 23-27 August 1982. (See sections II and III and Appendix II.)

2. Columbo, Guiseppe, "A Straightforward Use of the Shuttle E.T." Enclosure to letter from Dr. Colombo to Professor J.R. Arnold, Space Institute, University of California, San Diego, La Jolla, Ca 92037, dated March 1982.

3. Gatland, Kenneth, "Manned Spacecraft" pp 174-179, Library of congress card 67-22617.

4. Bekey, Ivan, "Architectural Options for Space Stations in the Context of the Space Infrastructure". Office of Space Flight, NASA Headquarters, Washington, D.C.

5. Modi, V. J. and Chang-Fu, Geng, "On the Control of the Space Shuttle Based Tethered Systems," Acta Astronautica, Vol. 9, No. 6-7, pp 437-443, 1982.

6. Misra, A. K., and Modi, V. J., "Deployment and Retrieval of a Subsatellite Connected by a Tether to the Space Shuttle", AIAA/AAS Astrodynamics Conference, Danvers, Mass. Paper No. AIAA-80-1693 (1980).

7. Rupp, C. C, "A Tether Tension Control Law for Tethered Subsatellites Deployed Along Local Vertical" NASA TMX-64963 (1975)

8. Baker, W. P., et al. "Tethered Subsatellite Study", NASA TM X-73314 (1976)

9. Kulla, P., "Dynamics of Tethered Satellites," Proc. Symp. on Dynamics and Control of Non-Rigid Spacecraft, Frascate, Italy, pp 349-354 (1976)

10. Kallaghan, P. N., et al "Study of the Dynamics of a Tethered Satellite System (Skyhook)", Final Report, Contract NAS8-32199, Smithsonian Institution, Astro/Physical Observatory, Cambridge, Mass. (1978)

11. Modi, V. J. and Mistra, A. K., "On the Deployment Dynamics of Tether Connected Two-Body Systems", Acta Astronautica 6, 1183-1197 (1979)

12. Misra, A. K. and Modi, V. J., "A General Dynamical Model for the Space Shuttle Based Tethered Subsatellite System", Adv. Astronaut. Sci. 40, 537-557 (1979)

13. Bainumm P.M. and Kumar, V. K., "Optimum Control of the Shuttle-Tethered-Subsatellite System", 30th Congress of the IAF, Munich, FRG, Paper No. 79-190 (1979)

14. Kane, Thomas R. and Levinson, David A., "Deployment of a Cable-Supported Payload From an Orbiting Spacecraft", J. Spacecraft, Vol. 14, No. 7, July 1977.

15. U.S. Patent 4,097,010 (27 June 1978), "Satellite Connected by Means of a Long Tether to a Powered Spacecraft", Guiseppe Colombo and Mario D. Grossi.

16. U.S. Patent 3, 532,298 (6 Oct. 1970), "Method for Deploying and Stabilizing Orbiting Structures", Charles T. Swet.

17. Technology Development Missions, Space Station NAAO Orientation Meeting, NASA Hq., 14-15 September 1982.

Narrative:

A tether system consists of two orbiting bodies connected by a flexible cable. The combined phenomena of gravity gradient and, centrifugal and Coriolis accelerations, make it possible to maneuver such a system in ways that may be useful in space operations. In particular, it is possible to interchange the positions of a pair of satellites, in high and low circular orbits, respectively, with little or no expenditure of propellant or mechanical energy. Angular momentum and energy of the system are conserved by values for the individual bodies are traded.

A tether scheme was patented by Swet in 1970 (Ref 16) and another by Colombo in 1978 (Ref 15). Since then, Dr. Colombo, and several others have studied the subject and made a number of specific proposals for operational applications - Refs 1 through 14. These range from bodies of a few 100 kg mass to the manned Shuttle Orbiter tethered to one or more of its external tanks (ETs). Cable lengths of 100 km have been suggested.

Preliminary tether tests were made during the Gemini program - see Ref 3 - and NASA has a contract, Tethered Subsatellite System (TSS), with Martin/Marietta and Aeritalia to develop hardware for experiments from a Shuttle Orbiter scheduled to fly in about two years time. This will involve an approximately 500 kg subsatellite with a 20 km cable to study electrodynamic effects. A later experiment is planned with a 100 km tether that will tow the subsatellite in the upper atmosphere.

Operations that involve one or more ETs tethered to the Orbiter are described in Ref 1 and 2. These include plans to have the Orbiter dock with the lower end of a tether, suspended from the tank in a high orbit, and then to rotate the system so as to interchange the orbits. Alternatively, the system could be stabilized with the Orbiter tethered immediately below the ET and an elevator could climb up or down the cables to carry propellant or payloads to higher orbit.

While such schemes do not violate any of the fundamental laws of physics, and behavior can in principle be predicted by analysis; feasibility should be demonstrated before attempting such operations with a manned Shuttle Orbiter. It is suggested that this could be done effectively and economically from an orbiting Space Station by making use of two Remotely Piloted Vehicles (RPVs) as outlined below.

B. TETHER MANEUVERING EXPERIMENT

Many tether systems have been proposed by Dr. colombo and others. Among them are schemes designed to accomplish the following tasks:

a. Raise or lower the Shuttle Orbiter to a different orbit by interchanging it with an ET previously placed in the different orbit.

b. Provide an elevator system that crawls up and down the cable between the Orbiter and ET.

c. Provide artificial gravity by spinning up the tether system.

Feasibility must be demonstrated before applying such ideas to a manned Shuttle Orbiter. It is suggested that this could be done effectively and economically from an orbiting Space Station, making use of two RPVs as outlined in the following paragraphs.

Rendezvous and Dock

Before considering useful tasks it is important to assure ability to rendezvous and dock with a tether system. The first RPV (RPV1) will be launched from the Space Station and use its own propulsion, guidance and control system to achieve a circular orbit about 20 km higher (or lower). It will carry as payload a winch and tether cable. A docking and homing device will be lowered by the cable to a height about 1 km above the Space Station.

The RPV/cable combination will have an orbital period that is slightly different from that of the Space Station, and on a subsequent orbit the second RPV (RPV2), carrying a docking device and an elevator, will be launched. This will then rendezvous and dock with the cable unit. Since the cable unit is not in free orbit by itself, it will be impossible for the RPV to achieve unpowered formation flight with the cable unit. Thus, the best that the chasing RPV can do is to make use of an orbit that approaches the cable unit and that momentarily provides zero relative velocity at one instant. In practice, RPV2 will have to use controlled thrusting to stationkeep with the cable unit while making the docking connection. This is the principal feature in which this type of docking differs from other free orbit docking events that have been accomplished previously.

In the attached sketches the tether system has been shown at an orbit above the Space Station and slightly ahead. For 20 km difference the tether will slip back about $1/3^{o}$ per orbit when station is at 200-300 km.

Interchange Orbits

When docking is complete, system should be observed for several orbits and rate of decay of oscillations (if any) should be noted. The interchange experiment can be initialized two different ways, one by "pumping" and the other by thrusting. Both should be tried to compare relative merits.

After residual oscillations from the docking transient have been observed sufficiently the cable should be partially retracted to increase angular velocity till the system "slips" over "top dead center". Cable "pumping" should then be initiated, with appropriate time phasing, to reduce oscillations.

When system has stabilized in the inverted position RPV2 should apply sufficient thrust to just "flip" the system over again, and when it has been reinverted a second thrust impulse will stabilize it again.

Energy dissipation and propellant usage for the two procedures should be compared as well as relative operational advantages and problems. These in turn should be compared with propellant that would have been required to perform the same maneuver by means of Hohmann transfer.

For this experiment, each RPV must be designed (with ballast if necessary) so that its principal axis of maximum moment of inertia is perpendicular to the plane of rotation. In addition the cable attachment point to each module should be offset from the module centroid in the direction of the cable length by about 10 or 20% of the maximum radius of gyration of the module. These two requirements are needed to assure a stable dynamic system that will not require continuous active control during the maneuver.

Spin for Artificial Gravity

RPV1 should apply an in-plane tangential thrust with sufficient magnitude to produce a definite spin rate. Radial acceleration (artificial gravity) should be measured as well as oscillations of the individual RPV modules relative to a reference frame that rotates smoothly with the tether system. Again it is mandatory that the principal axis of maximum moment of inertia of each module be perpendicular to the spin axis, and the cable attachment points be offset from each module centroid as required for the interchange experiment.

Spin should then be stopped with cable in the vertical position by means of a thrust impulse from one of the modules.

Payload Transfer Along the Cable (Elevator)

One of the RPV units, say RPV2, should carry a payload consisting of an "elevator" unit that is capable of climbing the cable. This unit must be designed to have its principal axis of maximum moment of inertia perpendicular to the orbital plane, and that of minimum moment of inertia in the direction of orbital motion. However, it should be supported from the cable at two points, which span its centroid. These requirements are needed to assure a stable dynamic system without continuous attitude control activities.

When the tether system is stabilized vertically the elevator should start to climb along the cable. Oscillations of each module and the elevator should be monitored as well as the power required for the climb. The pitch, roll, and yaw attitude angles of the elevator should also be monitored.

As the elevator climbs the cable, the system moment of inertia will decrease and angular momentum will be conserved if no thrusting torques are applied.

The tether system will, therefore, start to pitch relative to the vertical as the elevator climbs. As the angular velocity increases, the resulting oscillatory amplitude can be predicted. When the prediction reaches a pre-arranged value, say 20 degrees, the climb rate of the elevator should be stopped and the system allowed to pass through its maximum amplitude angle, and when it reverses direction, the elevator should be started climbing again. At this time the gravity gradient torque will offset the effect of conservation of angular momentum thus reducing the oscillation. This procedure should be used on successive cycles of system oscillation to keep the system from spinning up. The phasing should be reversed when the elevator gets above the system centroid.

Retraction of Tether System

When the elevator has been secured to RPV1 and the system stabilized vertically, RPV1 should begin reeling in the cable. As in the case of the elevator, conservation of angular momentum will cause the system to spin up. A procedure similar to that used with the elevator should be used to negate the rotation. As the cable becomes short, difficulty may be encountered without application of rocket thrust torque. However, one of the major features of tether systems centers around the ability to maneuver with little or no expenditure of propellant. For this reason development of efficient and effective operational means of retracting the system is of high priority.

Return to Space Station

When the cable has been retracted fully, the two RPVs can be docked together and flown back to the Space Station as a single unit using conventional rocket transfer and control procedures. Alternatively the cable could be disconnected from RPV2 and each RPV flown back to the Space Station independently.

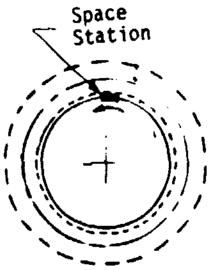
OPERATIONAL TIMELINE

Operation	Duration	Elapsed Time (Hrs)	$*\Delta\theta$(deg)
Unstow and countdown	6 Hrs		
Launch RPV1 and circularize in orbit 20-22 km above and 10-12 degrees ahead of Space Station	1 Orbit	6.0	
Launch RPV2 and circularize in orbit 1/2 km above and 10-12 degrees ahead of Space Station	1 Orbit	7.5	
Check orbits and lower tether from RPV1	1 Orbit	9.0	
RPV1 dock with end of cable	1 Orbit	10.5	11.0
Coast, observe oscillations and stability. Adjust amplitude by cylically changing cable length (pumping)	6 Orbits	12.0	10.7
Retract cable a small fraction of its length to increase angular velocity and interchange ends	2 Orbits	21.0	9.0
Re-extend cable and "pump" to stabilize after interchange	4 Orbits	24.0	8.5
Thrust with RPV2 to reinterchange positions	1 Orbit	29.9	7.3
Thrust with RPV2 to remove angular velocity and stabilize	2 Orbits	31.4	7.1
Thrust RPV2 to spin up. Coast and observe stability and artificial gravity while spinning	6 Orbits	34.4	6.5

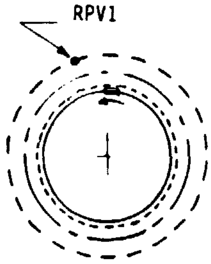
OPERATIONAL TIMELINE (Continued)

Operation	Duration	Elapsed Time (Hrs)	*$\Delta\theta$(deg)
Thrust RPV2 to stop spin and stabilize	3 Orbits	43.4	4.8
Raise elevator from RPV2 to RPV1	4 Orbits	47.9	4.0
Dock elevator with RPV1 and stabilize	1 Orbit	53.9	2.8
Retract cable and dock RPVs together	6 Orbits	55.4	2.5
Return to Space Station and Dock	2 Orbits	64.4	0.8
Restow	6 Hrs	67.4	0.3
Terminate mission		73.4	

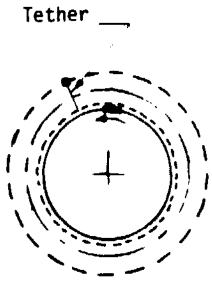
* $\Delta\theta$ angle (degrees) by which tether leads station



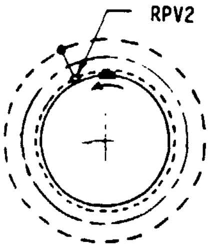
Launch RPV1



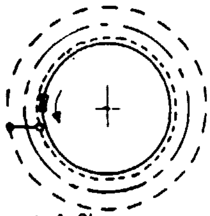
Modified Hohmann
Transfer to point above
& ahead of Suace Station



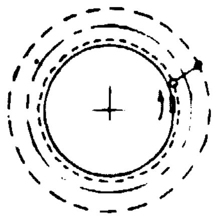
Lower Tether &
Stabilize.
Launch RPV 2

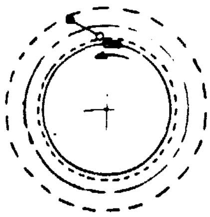


Rendezvous & Dock
with end of cable

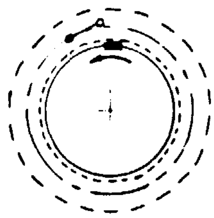


Coast & Observe
Oscillations and
stability. Adjust
amplitude by "pumping"
cable with appropriate
phasing

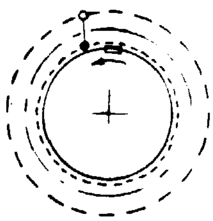




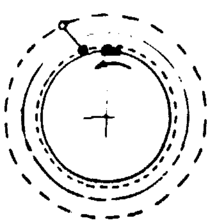
Increase amplitude
by "pumping" cable
with proper phasing



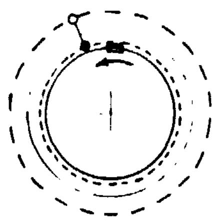
Pass top dead
center position
and interchange
RPV positions



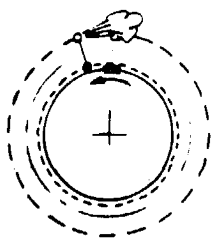
"Pump" cable to
decrease oscillations



Coast and continue
"pumping"



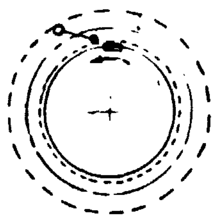
Stabilize

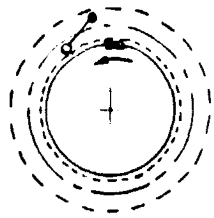


Thrust RPV2 to
re-interchange positions

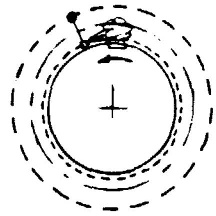
266.592-477

Code: GDCD 2510 PAYLOAD ELEMENT SYNTHESIS

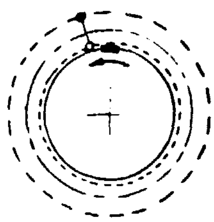




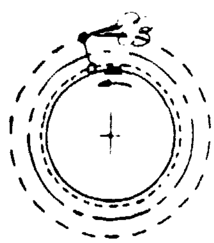
Coast and Interchange positions



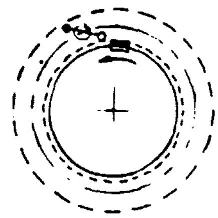
Remove angular velocity



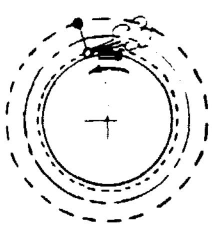
Stabilize



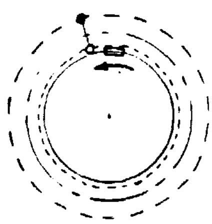
Thrust RPV1 to "spin-up"



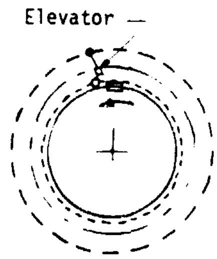
Coast and
Observe stability and artificial gravity while spinning



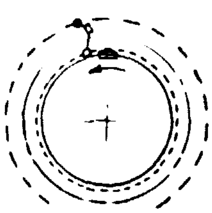
Thrust RPV2 to stop spin



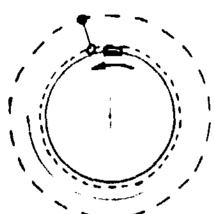
Stabilize



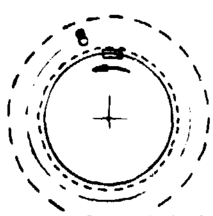
Start elevator up cable from RPV2



Cable "bows" due to Coriolis acceleration as elevator climbs



Stabilize after elevator docks with RPV1



Retract cable and dock RPV's together. Return to Space Station

266.592.478

Section 3.7

Discipline Fluid & Thermal Physics, Physics and Chemistry

GDCD ID NO.	PAYLOAD ELEMENT NAME
	(NOTE: Experiment facilities for fluid & thermal physics, physics and chemistry disciplines are contained in the general purpose research and development facilities described in Payload Elements GDCD 0400 and 0401.)
2601	Lightweight Cryo Heat Pipes

PAYLOAD ELEMENT NAME
Light Weight Cryo Heat Pipes

CODE G D C D 2 6 0 1

TYPE
- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☒ Technology Development
- ☐ Operations

Type Number (see Table A) 16

CONTACT
Name / Address: W. Hardy/J. Peterson MZ 21-9530
General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS
- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 1992
No. of flights 1
Duration of Flight, days 250

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

Scale 1 - 10 10

OBJECTIVE

Develop the technology necessary to manufacture and process heat pipes using cryogenic working fluids (e.g., hydrogen, nitrogen, oxygen, etc.) in a zero-g environment.

DESCRIPTION

The purpose of the mission is to investigate fabrication methods for manufacturing various types of large lightweight cryogenic heat pipes. Toward this end, several types of working fluids, heat-pipe configurations, fabrication techniques and cleaning and processing procedures should be investigated. Types of heat-pipe configurations might vary from a simple cylindrical configuration to more complex designs such as a flat plate sandwich panel or a variable conductance heat pipe. Fabrication techniques such as diffusion bonding or welding could be investigated together with cleaning, fluid charging, and sealing procedures. Several heat pipes will be fabricated and tested in space and their performance recorded. Earth testing will be impossible since the designs will be ultralight weight and not capable of containing the high internal pressures of the cryogenic working fluids at ambient temperature.

CODE GDCD2601

ORBIT CHARACTERISTICS

Apogee, km LEO Perigee, km LEO Tolerance + ______ -
Inclination, deg Any Tolerance + ______ -
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known) ______
Pointing accuracy, arc sec ______ Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	200	
Standby		
Peak		

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount) ______ Voice (Hrs/Day) ______
Live TV (Hrs/Day) ______ Other ______
On-Board Storage (MBIT) ______
Data Dump Frequency (Per Orbit) ______
Recording Rate (KBPS) 2 ______ Downlink Frequency (MHZ) ______

CODE G D C D 2 6 0 1

THERMAL

☐ Active ☒ Passive

Temperature, deg C — operational min ____ max ____
non-operational min ____ max ____

Heat Rejection, w — operational min ____ max ____
non-operational min ____ max ____

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m ____ W,m ____ H,m ____ Stowed

L,m 15 W,m 0.5 H,m 0.5 Deployed

Launch mass, kg 1000

Consumables Types Hydrogen, Nitrogen, Oxygen

Acceleration sensitivity, g min ____ max ____

CREW REQUIREMENTS

Crew Size 1 Task Assignment Initialize and Monitor

Skills (See Table B)

SKILL	7					
LEVEL	2					
Hrs/Day	1.6					

EVA ☒ YES ☐ NO Reason Set Up/Charge/Remove Hrs/EVA 176

SERVICING/MAINTENANCE

SERVICE: Interval, days 7 Consumables, kg 10 H_2, 100 N_2, 100 O_2

Returnables, kg ____ Man Hours 8

CONFIGURATION CHANGES: Interval, day ____ Man/Hrs Req. ____

Deliverables, kg ____ Returnables, kg ____

SPECIAL CONSIDERATIONS/See Instructions Anti-Earth, anti-solar pointing. Individual heat pipes of 25 mm to 250 mm in diameter. Three pipe sizes each used for 3 working fluids at 4 charge levels for total of 36 tests, 1 per week. Vacuum pump services required. Peak power 5000W, 5 min, 4 times per pipe during mission.

GDCD CODE 2601 ELEMENT NAME LIGHT WEIGHT CRYO HEAT PIPES

ACCOMODATION: [X] ATTACHED [ ] FREE FLYER [ ] OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1992 INT. HRS 2 EVA HRS 8 EVA CREW 2

[ ] NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 7 DAYS TOTAL SERVICES 36

[ ] TMS/OTV REQUIRED ______ STATION HRS PER SERVICE 4

[ ] NOT APPLICABLE ______ EVA HRS PER SERVICE 4

EVA CREW SIZE 1

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

1.6 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

[ ] NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

[ ] TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

[X] NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) 1992 INT. HRS. ______ EVA HRS 8 EVA CREW 2

[ ] NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Unpackage and set-up heat pipe experiment and radiator. Checkout instrumentation, heaters.
2. Initial change of working fluids. 36 tests total @ 1/wk, 3 different working fluids. Man would assist in returning working fluid to accumulator.
3. Initialize test and monitor internal pressure, temperatures heat inputs.
5. Purge, disassemble deployed pipes/radiators, instrumentation and package for earth return

TOTAL EVA HRS 176

Code: GDCD 2601

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Lightweight Cryo Heat Pipes

Reference Documents:

1. Technology Development Missions, Space Station NAAO Orientation meeting, NASA Hq., 14-15 Sept 1982

2. AIAA-80-0212, Performance Testing of a Hydrogen Heat Pipe, 18th AIAA Aerospace Sciences meeting, Pasadena, CA, J. Acario and R. Kosson, Grumman Aerospace Corp, Bethpage, NY, 14-16 Jan 1980

3. AIAA-80-0211, State of the Art on Cryogenic Heat Pipes, 18th AIAA Aerospace Sciences meeting, Pasadena, CA, R.C. Plager and A. Basiuulius, 14-16 Jan 1980

4. The International Heat Pipe Experiment, 2nd International Heat Pipe Conference 1976, R. McIntosh, S. Ollendorph, A. Sherman, NASA GSFC and W. Harwell Grumman Aerospace

Narrative:

The Heat Pipes of various diameters (1-10-in. diameters) would be made of extruded aluminum meticuously cleaned and charged with clean dry N_2 on the ground. On-orbit the pipes would be charged with the working fluid (nitrogen, hydrogen, oxygen) at various pressures.

Power is for instrumentation e.g., pressing transducers, temperature thermocouples) and for calibrated electrical heat input.

Approximately 100 measurement points x 2 samples per second x 8 bits provide the basis for the data rate at 2 kbps. The overall concept of the experiment is from Ref 1. Derived characteristics are from Ref 2, 3, and 4.

Working fluid is based on peripheral wall grooves 0.78-in. diameter per Ref 2. Three working fluids, 7 pipe sizes between 1-in. and 10-in. diameter and four charal levels were assumed. Approximately 6 months of payload operations are envisioned.

A vacuum pump would be required to capture working fluid in the accumulator prior to change of working fluid.

Pinch-off of the tubes uses a heated tool applied locally to a special stainless steel nozzle.

The instrumentation layout for the heat pipe is described from Ref 2. "A total of 10 thermocouples, each positioned at the 3 o'clock orientation, were used on the heat pipe proper; four each on both the evaporator and condenser sections, and two on the transport section. Two thermocouples were located on the heat pipe charge tube so that the heat transfer from the reservoir could be measured. Two more thermocouples monitored the reservoir temperature to ensure that it was always slightly warmer than the evaporator. A trace heater was attached to the reservoir so that any liquid trapped in it could be vaporized and returned to the heat pipe."

TECHNOLOGY DEVELOPMENT MISSION DESCRIPTION

Mission Title: Space Manufacturing and Processing Technology Development **Langley Contact:** Charles J. Camarda

Experiment Title: Fabrication of Lightweight Cryogenic Heat Pipes

Mission Objectives: Develop the technology necessary to manufacture and process heat pipes using cryogenic working fluids (e.g., hydrogen, nitrogen, oxygen etc.) in a zero-g environment.

Mission Description: The purpose of the mission is to investigate fabrication methods for manufacturing various types of large lightweight cryogenic heat pipes. Toward this end, several types of working fluids, heat-pipe configurations, fabrication techniques and cleaning and processing procedures should be investigated. Types of heat-pipe configurations might vary from a simple cylindrical configuration to more complex designs such as a flat plate sandwich panel or a variable conductance heat pipe. Fabrication techniques such as diffusion bonding or welding could be investigated together with cleaning, fluid charging, and sealing procedures. Several heat pipes will be fabricated and tested in space and their performance recorded. Earth testing will be impossible since the designs will be ultralightweight and not capable of containing the high internal pressures of the cryogenic working fluids at ambient temperature.

Benefit: Heat pipes may play a very large role in space as radiators for space stations or satellites or possibly in the design of thermally inert distortion free structures such as large space antennas or optical systems such as lasers or telescopes. Most of the above applications will require heat pipes using cryogenic working fluids whose structural design will be dominated by the very high internal pressures of the cryogenic fluids at room temperature. Manufacture of these heat pipes in space would result in large savings in mass.

Justification: The fabrication of large ultralightweight cryogenic heat pipes (approximately 50 ft.) will require extended use of a large, low temperature environment afforded by the space station. Also, the need for human interaction is necessary in the fabrication as well as the testing aspects of the experiment since ground testing is not feasible.

Mission Requirements and Capability: Low temperature cryogenic area necessary for fabricating heat pipes 50 feet or longer. Power necessary for welding or diffusion bonding and for testing and data collection should be at normal levels.

Space Station vs. Free Flyer: The proposed experiment needs continued human interaction during the fabrication and test processes. It is not conceivable that fabrication be done on a free flyer because of the complexity of procedures involved in the fabrication, cleaning, and processing of the heat pipes.

OTHER MISSIONS
OPERATIONAL

Section 4.1

Discipline Maintenance

GDCD ID NO.	PAYLOAD ELEMENT NAME
	No payload elements identified in this discipline.

Section 4.2

Discipline Other

GDCD ID NO.	PAYLOAD ELEMENT NAME
4000	Manned Geosynchronous Sortie Capsule
4001	Manned Geosynchronous Support Module

PAYLOAD ELEMENT NAME
Manned GEO Sortie Capsule

CODE G D C D 4 0 0 0

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

☐ Operational
☐ Approved
☐ Planned
☒ Candidate
☐ Opportunity

First flight, yr 1999
No. of flights 6
Duration of Flight, days 1

OBJECTIVE

Demonstrate manned capability for geosynchronous operations as a precursor to long-term manned geosynchronous operations.

TYPE

☐ Science & Applications (non-commercial)
☐ Commercial
☐ Technology Development
☒ Operations

Type Number (see Table A) 18

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 4

DESCRIPTION The manned geosynchronous sortie capsule is delivered by the Shuttle to the Space Station where systems are checked out and the capsule is manned. The capsule could be mated to the upper stage at LEO prior to departure, or the capsule/upper stage could be delivered simultaneously. The upper stage delivers the capsule to GEO where it remains attached for 1 - 2 days while manned operations are conducted. The upper stage injects the capsule into return transfer orbit. The capsule uses aerodynamic braking to assist in returning to LEO. Initial launch is 1999, one per year thereafter.

CODE G D C D 4 0 0 0

ORBIT CHARACTERISTICS

Apogee, km 35,786 Perigee, km 35,786 ______ Tolerance + ______ - ______

Inclination, deg 0 ______ Tolerance + ______ - ______

Nodal Angle, deg ______ Ephemeris Accuracy, m ______

Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ______

Pointing accuracy, arc sec ______ Field of view, deg ______

Pointing Stability (Jitter) arc sec/sec ______

Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	______	______
Standby	______	______
Peak	______	______

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☐ Realtime ☐ Offline ☐ Other ______

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______

☐ On-Board Data Processing Required

Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______

Film (Amount) ______ Voice (Hrs/Day) ______

Live TV (Hrs/Day) ______ Other ______

On-Board Storage (MBIT) ______

Data Dump Frequency (Per Orbit) ______

Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

CODE G D C D 4 0 0 0

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 4.4 W,m 3.3 H,m 3.3 Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 4535

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2 Task Assignment P/L Handling and Checkout

Skills (See Table B)

SKILL	7	5				
LEVEL	1	2				
Hrs/Day	8	4				

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Power will be self-supplied during checkout. Capsule consists of command module (Apollo shape) with reusable aerobrake and service module (propulsion and fuel cells). Total of 6 sortie missions, 1/year starting in 1999. Service required between missions; LEO or Earth location TBD.

GDCD CODE 4000 ELEMENT NAME MANNED GEO SORTIE CAPSULE

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 1999 INT. HRS ______ EVA HRS ______ EVA CREW ______

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL 360 DAYS TOTAL SERVICES ______

☐ TMS/OTV REQUIRED ______ STATION HRS PER SERVICE ______

☐ NOT APPLICABLE ______ EVA HRS PER SERVICE ______

EVA CREW SIZE ______

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

12 HRS PER DAY (INTERNAL)

______ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ______ DAYS TOTAL RECONFIGS. ______

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ______

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ______

EVA CREW SIZE ______

5. DEACTIVATION/REMOVAL

DATE(S) ______ INT. HRS. ______ EVA HRS ______ EVA CREW ______

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. Initial launch date, one flight per year for 6 years.
2. Service required between missions. Service location (LEO vs Earth) is TBD
3. 2 man crew for P/L handling and P/L checkout (sortie capsule is manned when launched from LEO

TOTAL EVA HRS 0

Code: GDCD 4000

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Manned Geosynchronous Sortie Capsule

Reference Documents:

1. Discussions with JSC, 2 Feb 1983

2. Nominal Mission Model, Rev. 6, MSFC PS01, 9/30/82

Narrative:

The data for this payload element is based on Ref 1 using a stretched Centaur or equivalent upper stage.

The launch data is from Ref 2.

Crew data and mission duration are derived assuming payload handling at LEO is required. Payload handling on return from GEO is assumed to be routine station operations. The checkout concept assumes an automatic system controlled and monitored by station crew. Top off of Sortie Capsule fuel cells or upper stage cryogenics may be required.

PAYLOAD ELEMENT NAME
Manned GEO Support Module

CODE G D C D 4 0 0 1

CONTACT
Name W. Hardy/J. Peterson MZ 21-9530
Address General Dynamics Convair Division
P.O. Box 85357
San Diego, CA 92138

Telephone (619) 277-8900, Ext. 3778/2130

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☒ Candidate
- ☐ Opportunity

First flight, yr 2002
No. of flights 1
Duration of Flight, days 1

TYPE

- ☐ Science & Applications (non-commercial)
- ☐ Commercial
- ☐ Technology Development
- ☒ Operations

Type Number (see Table A) 18

Importance of the Space Station to this Element

1 = low value but could use
10 = vital

Scale 1 - 10 4

OBJECTIVE

Provide short-term support for man to perform geosynchronous altitude operations (e.g., Earth observations) as a precursor to an operational GEO platform.

DESCRIPTION The operations concept uses the Shuttle to deliver the support module/upper stage to low Earth orbit or the module could be mated to upper stage at LEO prior to departure. The upper stage delivers the module to GEO (unmanned) for rendezvous with a manned sortie capsule (Ref. GDCD 4000). The support module provides crew accommodations for approx. 2 weeks. The sortie capsule is used to return the crew to the Space Station or Shuttle at LEO. The support module remains on orbit awaiting the next manned sortie mission.

CODE G D C D 4 0 0 1

ORBIT CHARACTERISTICS

Apogee, km 35,786 Perigee, km 35,786 Tolerance + ______ - ______

Inclination, deg 0 ______ Tolerance + ______ - ______

Nodal Angle, deg ______ Ephemeris Accuracy, m ______

Escape dV Required, m/s ______

POINTING/ORIENTATION

View direction ☐ Inertial ☐ Solar ☐ Earth

Truth Sites (if known) ______

Pointing accuracy, arc sec ______ Field of view, deg ______

Pointing Stability (Jitter) arc sec/sec ______

Special Restrictions (Avoidance) ______

POWER

☐ AC ☐ DC

	Power, W	Duration, hrs/day
Operating	______	______
Standby	______	______
Peak	______	______

☐ Continuous

Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS

Monitoring requirements:

☐ None ☐ Realtime ☐ Offline ☐ Other ______

☐ Encryption/Decryption Required

☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______

☐ On-Board Data Processing Required

Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______

Film (Amount) ______ Voice (Hrs/Day) ______

Live TV (Hrs/Day) ______ Other ______

On-Board Storage (MBIT) ______

Data Dump Frequency (Per Orbit) ______

Recording Rate (KBPS) ______ Downlink Frequency (MHZ) ______

CODE G D C D 4 0 0 1

THERMAL

☐ Active ☐ Passive

Temperature, deg C operational min ______ max ______

non-operational min ______ max ______

Heat Rejection, w operational min ______ max ______

non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS

Location: ☐ Internal ☒ External ☐ Remote

Equipment ID/Function ☐ Pressurized ☒ Unpressurized

L,m 6.8 W,m 4.5 H,m 4.5 Stowed

L,m ______ W,m ______ H,m ______ Deployed

Launch mass, kg 8160

Consumables Types ______

Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS

Crew Size 2

Task Assignment P/L Handling and Checkout

Skills (See Table B)

SKILL	7	5				
LEVEL	1	2				
Hrs/Day	8	4				

EVA ☐ YES ☒ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE

SERVICE: Interval, days ______ Consumables, kg ______

Returnables, kg ______ Man Hours ______

CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______

Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

Power will be self-supplied during checkout. Support module provides refrigeration equipment for upper stage boil-off.

PAYLOAD ELEMENT OPERATIONS DESCRIPTION

GOCD CODE 4001 ELEMENT NAME MANNED GEO SUPPORT MODULE

ACCOMODATION: ☐ ATTACHED ☒ FREE FLYER ☒ OTV OPS

1. STATION ACTIVATION (E.G., SET-UP/ASSEMBLY/ATTACHMENT AND CHECKOUT)

DATE(S) 2002 INT. HRS ____ EVA HRS ____ EVA CREW ____

☐ NOT APPLICABLE

2. SERVICE (E.G., REPLENISH/RESUPPLY)

INTERVAL ____ DAYS TOTAL SERVICES ____

☐ TMS/OTV REQUIRED ____ STATION HRS PER SERVICE ____

☒ NOT APPLICABLE ____ EVA HRS PER SERVICE ____

EVA CREW SIZE ____

3. STATION OPERATIONAL SUPPORT (AVG. TIME FOR MONITOR, INSPECT, ETC.)

12 HRS PER DAY (INTERNAL)

____ HRS PER DAY (EVA)

☐ NOT APPLICABLE

4. RECONFIGURATION

INTERVAL ____ DAYS TOTAL RECONFIGS. ____

☐ TMS/OTV REQUIRED STATION HRS PER RECONFIG. ____

☒ NOT APPLICABLE EVA HRS PER RECONFIG. ____

EVA CREW SIZE ____

5. DEACTIVATION/REMOVAL

DATE(S) ____ INT. HRS. ____ EVA HRS ____ EVA CREW ____

☒ NOT APPLICABLE

6. NOTES (BRIEFLY DESCRIBE TASKS IN 1 THROUGH 5 ABOVE)

1. 1 flight required
3. 2 man crew for P/L handling, and checkout. Support module launched unmanned.
5. Payload remains at GEO orbit.

TOTAL EVA HRS 0

Code: GDCD 4001

PAYLOAD ELEMENT SYNTHESIS

Payload Element Name: Manned Geosynchronous Support Module

Reference Documents:

1. Discussions with JSC, 2 Feb 1983.

2. Nominal Mission Model, Rev. 6, MSFC PS01, 9/30/82

Narrative:

The data for this payload element is based on Ref 1 using a stretched Centaur, or equivalent, upper stage.

The launch data is from Ref 2.

Crew data and mission duration are derived assuming payload handling at LEO is required. The checkout concept assumes an automated system controlled and monitored by the Space Station crew (or by the Shuttle).

APPENDIX II
SPACE STATION USER BROCHURE AND FACT SHEET

TABLE OF CONTENTS

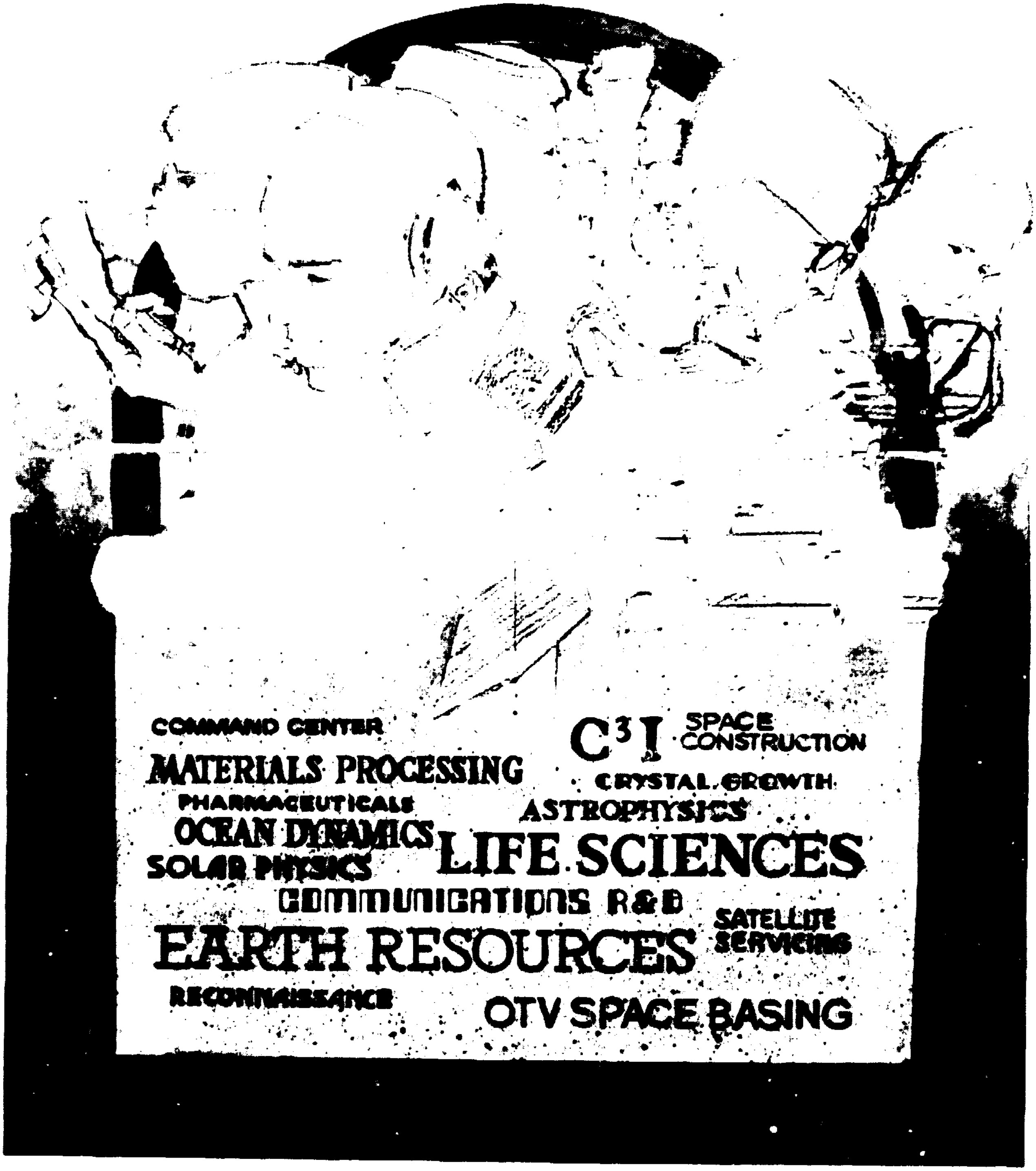
INTRODUCTION

The Space Station User Brochure and Fact Sheet have been developed by General Dynamics Convair Division in support of the National Aeronautics and Space Administration's Study on the Space Station Needs, Attributes, and Architectural Options (Contract NASW 3682). The brochure has been provided to a select group of organizations that qualify for consideration as potential Space Station users.

There were two purposes for this brochure. First, to present potential user organizations with vital information regarding the scientific and industrial opportunities that a Space Station might present. Second, to offer potential users an opportunity to become directly involved in NASA's Space Station program. The brochure details the potential technological and economic benefits of a manned Space Station, while also offering a concise summary of America's current and planned space activities. The accompanying User Fact Sheet allows potential users to influence Space Station program planning by identifying economic planning factors as well as areas of insterest in Space Station provisions.

GDC-ASP-83-002

SPACE STATION USER BROCHURE



GENERAL DYNAMICS
Convair Division

INTRODUCTION

The Space Station User Brochure has been developed by General Dynamics Convair Division in support of the National Aeronautics and Space Administration's current Study on Space Station Needs, Attributes, and Architectural Options. The brochure has been provided to a select group of organizations that qualify for consideration as potential Space Station users.

There are two purposes for this brochure. First, we want to present potential user organizations with vital information regarding the scientific and industrial opportunities that a Space Station might present. Second, we want to offer potential users an opportunity to become directly involved in NASA's Space Station program. The brochure details the potential technological and economic benefits of a manned Space Station, while also offering a concise summary of America's current and planned space activities. The accompanying User Fact Sheet allows potential users to influence Space Station program planning by identifying areas of interest in Space Station provisions.

General Dynamics encourages all potential users to read the Space Station User Brochure and to return the completed Fact Sheets to General Dynamics Convair Division as early as is practical. This represents an excellent opportunity for all interested organizations to participate in and shape the development of an important new program.

Prepared by
SPACE STATION PROJECT
GENERAL DYNAMICS CONVAIR DIVISION
P.O. Box 80847
San Diego, California 92138

MR. OTTO STEINBRONN Mail Zone 21-9530
Phone (714) 277-8900 x-6082

SPACE STATION OPPORTUNITIES

The development of a manned Space Station will provide many opportunities for new and improved uses of space. In scientific research and applications, the establishment of a permanent human presence in space will improve our ability to carry out, interpret, and modify a broad variety of experiments, particularly in the life sciences. The Space Station will also provide new opportunities for commercial use of space, notably in such areas as materials processing and space transportation. This section describes some of the significant opportunities that may develop in these areas over the next several years.

SCIENCE AND APPLICATIONS

By providing a base for continuous research and applications activities of unlimited duration, the Space Station will open up opportunities for scientific investigation previously unavailable. The Space Shuttle, particularly when used with the European-built Spacelab, will support hundreds of independent scientific activities over the next decade, but is limited in effectiveness by its size and its maximum stay-time in orbit.

Using a modular design, a Space Station could be expanded indefinitely to support simultaneously a number of large scientific instruments, which could be flown in the Shuttle only one at a time. Whereas the Shuttle can remain in orbit for a maximum of only seven days (slightly longer with modifications to the orbiter power supply) a Space Station could support space science and applications experiments of many months or even years duration.

With less stringent limitations on experiment size and duration, the Space Station will provide unique opportunities and cost benefits to researchers in such fields as earth and space observation and space processing R&D. Large telescopes and other such instruments could be attached directly to the Space Station, or could be supported on co-orbiting, free-flying platforms within easy access to the Space Station crew. The ability to modify and repair experimental facilities on short notice will be another key advantage of using a Space Station for space science and applications.

In the area of applications, the Space Station will provide opportunities to improve earth observation instrumentation and to enhance remote sensing by adding human monitoring capabilities. Applications of remote sensing include such environmental observations as air quality monitoring, detection of ocean currents, and weather prediction. (Earth resource monitoring, the other primary remote sensing activity, is discussed in "Commercial Utilization," below.) The presence of humans in space will help to ensure that local changes in the earth's environment can be picked up by remote sensing instruments, and will also provide an in-space capability for handling data and correcting technical problems.

Important benefits of the Space Station for science and applications will be realized in the field of life sciences. The Space Station will permit research on the long-term effects of the space environment on humans and other living systems, far surpassing the capabilities of the Shuttle and the now-extinct Skylab. By combining the ability to repair or modify life sciences experiments on a moment's notice with this capability for long-duration observation and experimentation, the Space Station will provide great new opportunities for:

- Improving the health and performance of humans living and working in space.
- Increasing our understanding of life processes both in space and on Earth.
- Understanding the origin, evolution, nature, and distribution of life in the Universe.

In the more distant future, the Space Station could play a role in such scientific and applications endeavors as the collection and processing of nonterrestrial materials (e.g., lunar ore) on an experimental scale, and the staging of unmanned and manned interplanetary (or even intergalactic) missions. By the time the Space Station exhausts its utility to the scientific community, missions such as these might seem primitive.

COMMERCIAL UTILIZATION

As a vital step in the direction of space industrialization, the Space Station will create significant and varied opportunities for commercial use of space. Near-term business opportunities in such areas as commercial materials processing in

space and flight support operations could generate several billions of dollars in revenue annually by the middle of the next decade, while such long-term activities as extra-terrestrial mining and space construction provide the potential for virtually limitless industrial growth in space.

Several large companies have already taken steps to capitalize on the commercial potential of materials processing in space (MPS). McDonnell Douglas Astronautics Co. and Ortho Pharmaceutical Co. (a subsidiary of Johnson and Johnson) have committed tens of millions of dollars to a Joint Endeavor with NASA aimed at commercial-scale electrophoretic separation of high-value pharmaceuticals in space. The properties of zero gravity are expected to create opportunities for the production of other valuable materials in space, such as gallium-arsenide, a crystal used in semiconductors, which could have a profound impact on the electronics industry. NASA's Materials Processing in Space Office has been working with private industry for over five years to identify commercially viable MPS opportunities, and arrangements such as NASA's Joint-Endeavor program are being used to encourage the use of the Space Shuttle for MPS.

By providing more power and greater production time than the Space Shuttle, the Space Station will permit the production of much greater quantities of materials than would be possible on the Shuttle, opening up new opportunities for commercial MPS. The element of manned presence will aid in the improvement and creation of new processes, further enhancing the prospects for commercial space processing.

As a staging base for high-energy upper stages, the Space Station may open up commercial opportunities in space transportation that could impact the evolution of the entire space communications industry. Initial studies have indicated that a reusable orbital transfer vehicle (OTV) based at a Space Station could deliver payloads to geosynchronous orbit more cheaply than any other available means. Based on traffic models projecting launches of some five hundred communications satellites over the next twenty years, the market for OTV launch services could exceed $20 billion within the communications industry alone.

The reduction of launch costs could in turn stimulate the development of larger and more capable communications satellites, creating opportunities both on Earth for advanced communications equipment (e.g., "wristwatch" telephones), and in space for satellite servicing. OTV operations could also represent an attractive business opportunity in the launch of non-communications payloads, such as scientific instruments, to high or interplanetary orbits.

Another area of potential commercial involvement in Space Station operations is in remote sensing. Earth resource observations can be used to detect geological minerals, petroleum, or to monitor development of crops, water resources, and timber. As in the area of environmental observations (discussed in "Science and Applications" above), a manned Space Station will provide opportunities to increase the operational effectiveness and reliability of these remote sensing systems.

The Space Station could create other business opportunities in the intermediate- and long-term in such areas as use of nonterrestrial materials and space construction. These technologies could be used in such activities as the development of large power systems for provision of energy in space (and to Earth, if it becomes economically and environmentally feasible) and perhaps even the establishment of permanent human settlements in space. As a prerequisite to all of these developments, the Space Station represents a key early investment opportunity in the industrialization of space.

SPACE OPERATIONS

Provision of operational support to Space Station users represents an opportunity for organizations which are not traditionally space-oriented to become involved in Space Station development and operation. In addition to OTV flight support operations (see "Commercial Utilization), Space Station users will require data handling, utilities such as power, environmental management (i.e., food, water, waste disposal, etc), and other support. Development and provision of the technological and economic means of providing this support could become a valuable investment opportunity for Space Station "providers" of services.

SPACE TRANSPORTATION SYSTEM ATTRIBUTES

The Space Shuttle is the key to routine U.S. access to space. It is the major technological factor that permits economic emplacement and support of a permanent manned facility in low earth orbit.

As illustrated in Figure 1, the Shuttle will fulfill many functions in the overall Space Transportation System (STS) scenario, and its role will change with time. Initially, delivery of low earth orbit (LEO) spacecraft, geosynchronous orbit (GEO) spacecraft with upper stages, and space sortie payloads will account for almost all of its missions.

Later, it will add LEO spacecraft servicing and retrieval, and Space Station delivery and assembly capabilities. Finally, as the Space Station grows and evolves into the predominant U.S. space presence, the Shuttle, which was originally conceived as a transportation system to provide routine and economical access to a manned Space Station, will transition from a mission performance vehicle to its primary role as a transportation vehicle, allowing the full potential of the Shuttle to be realized.

The Space Station will be a key element in making Shuttle operations more economical and efficient as it serves as a staging base for transferring payloads to other orbits. This will relieve the Shuttle of its on-orbit operational role so that it can focus on transportation from earth to LEO and return.

As the scale of Space Station activities expands, user economic benefits will accrue because of lower net transportation costs and economy of scale in providing payload supporting services.

The following sections describe the present and planned elements of the STS, and discuss the principles that will lead to more economic operations in space as these elements evolve in capabilities.

STS SYNOPSIS

Major elements of the STS through the year 2000 will be:

- Space Shuttle
- Spacelab
- Free Flyers
- Space Platform
- Space Station
- Orbit Transfer Vehicles
- Support Facilities

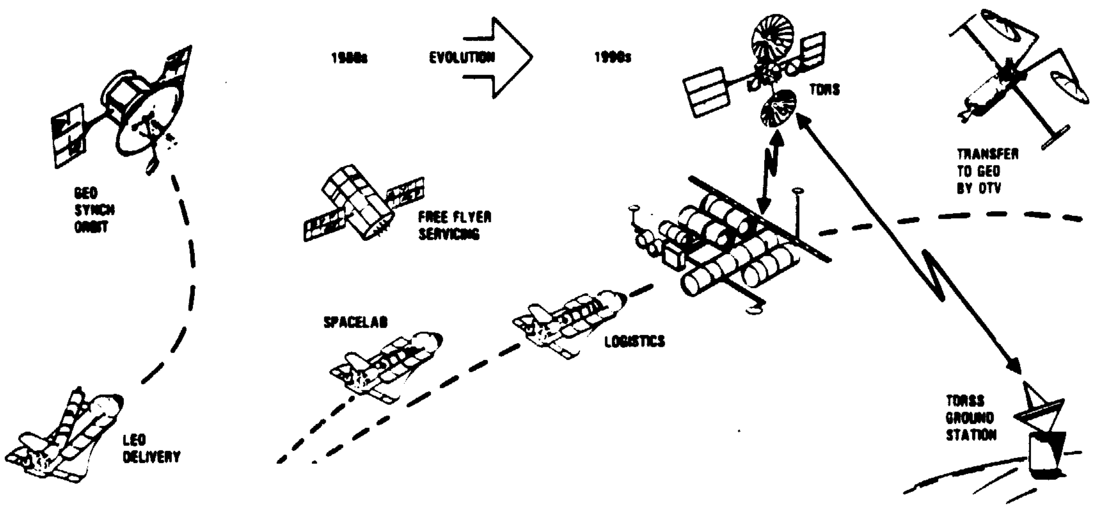


Figure 1. Space Shuttle supports all elements of the total STS scenario with an evolutionary role that parallels the Space Station program.

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Space Shuttle — Payload elements can be mounted directly to standardized attachment fittings along the sides and bottom of the Orbiter's cargo bay.

The payload clearance envelope in the cargo bay measures 18.3 m (60 ft) in length and 4.6 m (15 ft) in diameter.

The cargo bay is vented to the exterior ambient pressure during flight. The Orbiter supplies basic services such as power, cooling and data management. Payloads can be controlled from the Orbiter's aft flight deck or from the ground.

A small amount of payload equipment (e.g., 2 to 4 m^3) can be accommodated within the Orbiter cabin, where limited power, cooling and data management services are provided.

The choice of location will depend on factors such as size, the need for manned access, and whether the equipment requires direct exposure to space.

The Orbiter carries a crew of at least four for payload deployment and retrieval missions and as many as seven for Spacelab flights. In addition to the Commander and Pilot, one or two Mission Specialists will be available to operate the remote manipulator system, docking and berthing devices, and other Orbiter subsystems and auxiliary equipment. The mission specialists are trained astronauts and are EVA-capable (extra-vehicular activity).

Three or four Payload Specialists may be carried who are trained in the operation of specific experiments. The relatively benign Shuttle environment and shirtsleeve laboratory operations require a minimum of acclimation by scientists and engineers.

The Orbiter can launch as much as 29,484 kg (65,000 lb) of payload equipment into a low inclination, low altitude earth orbit. Higher altitudes and/or inclinations somewhat reduce this launch capability.

The weight of cargo returned to earth is limited to 14,514 kg (32,000 lb), due to Orbiter landing weight constraints.

In the pre-Space Station era, Shuttle missions will be devoted primarily to deliveries of autonomous spacecraft to low earth orbit (LEO) and to deliveries to LEO parking orbit of geosynchronous orbit (GEO) spacecraft with orbit-to-orbit transfer stages, and earth-escape missions. A small percentage of the Shuttle flights will be devoted to Spacelab missions.

To improve launch factors, many satellite delivery missions will include two or three satellites in the cargo manifest (see Figure 2) and some will also include a palletized science or materials-processing payload in the cargo bay to take advantage of remaining time on orbit; i.e., three to four days.

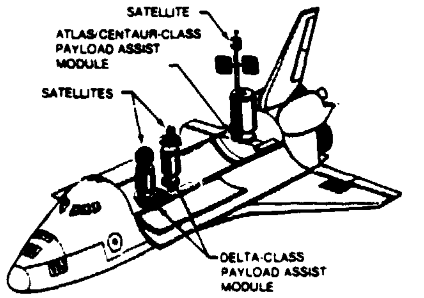

Figure 2. Multiple small satellites can be launched on each Shuttle flight.

In the Space Station era, the predominant role of the Shuttle will be to serve as a logistics vehicle for the station and station-related operations. After initial Space Station buildup, the Shuttle's major functions will be to provide for crew rotation, resupply consumables, deliver equipment and raw materials to the station, and to return manufactured products and wastes to earth.

The currently planned four-Orbiter fleet may have to be expanded to accommodate the increased earth-to-LEO traffic in the Space Station era.

Spacelab — The array of possible Spacelab configurations (combinations of large or small modules and/or number of pallet sections) provides a wide range of payload mass capabilities and pressurized or unpressurized accommodations (see Figure 3).

The large module can accommodate up to approximately 6,000 kg and 20 m^3 of payload equipment. Present planning includes about three Spacelab missions per year after 1983. These missions are scheduled for a seven-day duration. Intensive preflight payload integration and crew training efforts, and mission timeline controls are

necessary to make the most out of the short on-orbit stay time available. Longer-duration (up to 30 days) missions are feasible, but at the expense of payload weight penalties to account for mission-dependent consumables and, possibly, a power extension package.

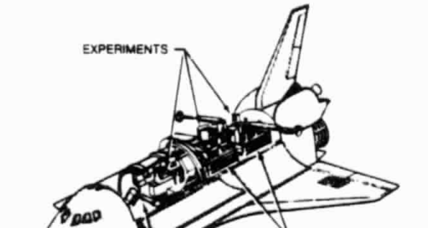

Figure 3. Spacelab provides pressurized laboratory and unpressurized instrument mounting facilities.

Free Flyers — The Shuttle will deliver to LEO autonomous, free-flying spacecraft exemplified by the Space Telescope, Solar Max Satellite, Long Duration Exposure Facility (LDEF), Landsat, Advanced X-Ray Astrophysics Facility, and the Gamma Ray Observatory.

Figure 4 illustrates the Solar Maximum Satellite (SMS) which consists of a Solar Astronomy payload supported by a Multimission Modular Spacecraft (MMS).

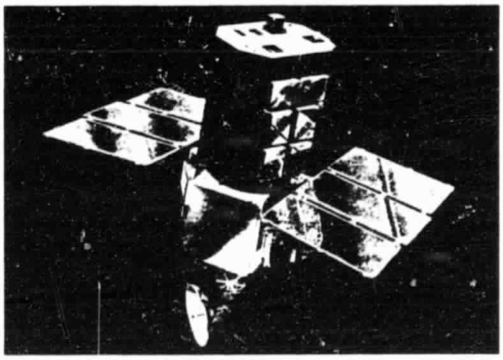

Figure 4. SMS is a typical MMS application that is serviceable on orbit and is retrievable for refurbishment and reuse.

The MMS has been developed by NASA as a standard modular spacecraft, that can be used in both low and high orbits. Within its standard range of capabilities, it can be adapted to many varied payload requirements, eliminating the need for costly and time-consuming design and development activities.

The MMS can accommodate payloads in excess of 4,536 kg (10,000 lb) when launched/retrieved by the Shuttle, can supply 800 watts average power to the payload, and has a basic pointing accuracy of 0.01 degree that can be improved by two to three orders of magnitude using a payload sensor-derived signal.

The MMS is also currently used for the LANDSAT-D series of earth observations satellites, and a power-augmented version of the MMS has been proposed to support a free-flying materials processing payload that would manufacture pharmaceutical products in a microgravity environment.

These spacecraft are also being designed for periodic on-orbit servicing using the Shuttle and for Shuttle retrieval for return to earth for refurbishment (see Figure 5).

In the Space Station era, servicing and refurbishment will be possible at a station servicing facility if orbit compatibility permits, or if an appropriate station-based propulsive stage is employed.

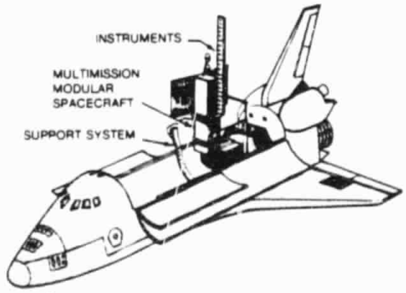

Figure 5. The MMS and its support system permit on-orbit servicing and retrieval.

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Space Platform — One programmatic option under consideration in the evolution of the STS is the use of an unmanned, free-flying space platform that could accommodate a large complement of science and applications payloads (see Figure 6).

This STS element could provide long mission durations which are desired by many scientific observations. It could also provide high power levels that could permit materials processing in space to enter a commercial scale of operations. Addition of manned modules to the Space Platform could be a step in evolving from a Shuttle-tended to an autonomous mini-Space Station.

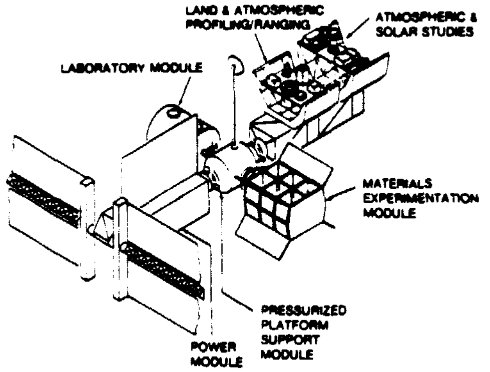


Figure 6. The Space Platform could accommodate payloads with a wide range of viewing, microgravity, and space access requirements.

Space Station — The Space Station will be a manned, permanent orbital facility that will support a wide variety of U.S. and international space missions. It will provide space laboratory and manufacturing facilities, viewing platforms, and operational support functions.

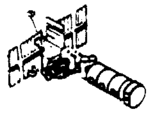
The station will begin as a small science and research-oriented facility with a small crew, and will evolve to a large, multipurpose system with a crew of a dozen or more over the time period of interest. Initially, the crew of scientist/astronauts will be trained to perform Mission and Payload Specialist duties. Later, Principal Investigators and other user representatives will be able to conduct on-orbit Science and Applications research, material processing, and other activities.

Modular design and delivery/assembly by the Shuttle will provide flexibility in accommodating varying user needs. Figure 7 illustrates a representative evolutionary buildup in the station configuration and its mission capabilities.

In the initial buildup phase, users may share laboratory facilities for R&D investigations, while in the advanced stage the facility capabilities can expand to meet user needs; e.g., dedicated manufacturing or processing facilities, space-based OTV propellant resupply and servicing, and launch support for GEO payloads.

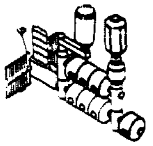
Ultimately, two or more Space Stations will be needed by the U.S. to accommodate user requirements for viewing vantage, laboratory and manufacturing facilities in space, electrical power, and other resources.

INITIAL PHASE



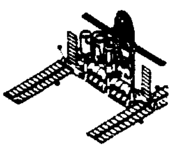
- Multidiscipline laboratory
- R&D experiments; e.g., proof of phenomena or proof of concept
- Solar, stellar, earth viewing

OPERATIONAL PHASE



- Additional power, laboratories, habitability
- Operational support for LEO free flyers: service, repair, update
- Process development
- Pilot plant production

ADVANCED PHASE



- Additional power, laboratories, habitability
- Operational support for LEO free flyers: deploy, retrieve, service, repair, update
- Operational support to launch GEO payloads:
  - Assembly and checkout
  - Space-based OTVs
- Space construction support
- Dedicated full-scale production facilities; i.e., commercialization

Figure 7. Evolutionary growth in station capabilities will be a function of user requirements.

The initial facility will be placed in a low-altitude orbit, with an orbit inclination in the range of 28.5 to 57 degrees. The lower-inclination orbit would allow the Shuttle to deliver its full 29,484 kg payload, and would provide an efficient waypoint for launching payloads and OTVs to GEO.

The higher-inclination orbits would provide some additional earth viewing opportunities, but at the expense of payload delivery capability. Later, smaller facilities can be emplaced in polar orbit to provide optimum viewing opportunities for solar physics and earth observations.

As the Space Station evolves during the 1990s, the expanded level of commercial and operational activities will generate a diversified flow of equipment, consumables, and products between the station and earth. This diversity will enable the Shuttle operator to plan cargo manifests to obtain nearly 100% load factors, thus minimizing the cost per kilogram transportation costs. Figure 8 indicates this diversity of Shuttle cargo in the Space Station era.

For laboratory and manufacturing facilities, the delivery of equipped modules to orbit and attachment to the station for long periods will significantly reduce the mass flow to and from orbit since only raw materials, manufactured products, and periodic replacement equipment must be transported, rather than the entire facility (as in the case of Spacelab). This long-term emplacement of modules could reduce the mass flow for a typical space-manufactured product to tens of kilograms rather than thousands.

Orbit Transfer Vehicles — The majority of autonomous spacecraft to be launched to LEO by the Shuttle will operate at GEO. In the early years, they will be transferred from the LEO parking orbit into a transfer ellipse by propulsive stages such as the payload assist module (PAM-A and -D), or will be placed in GEO by the inertial upper stage (IUS).

In the later years, this orbit-to-orbit transfer function will be performed by high-energy propulsive stages that can carry larger payloads or can emplace multiple payloads. Initially, the OTV will be carried to LEO along with its payload(s). The Space Station will have no role in these launches. But, as station support capabilities grow, the opportunity will be available to use the station as a launching base for these GEO payloads. This will permit much larger spacecraft to be assembled and checked out in LEO and then transferred to GEO using a station-based, reusable OTV. This capability could also enable the buildup and launch of advanced interplanetary probes and sample return missions.

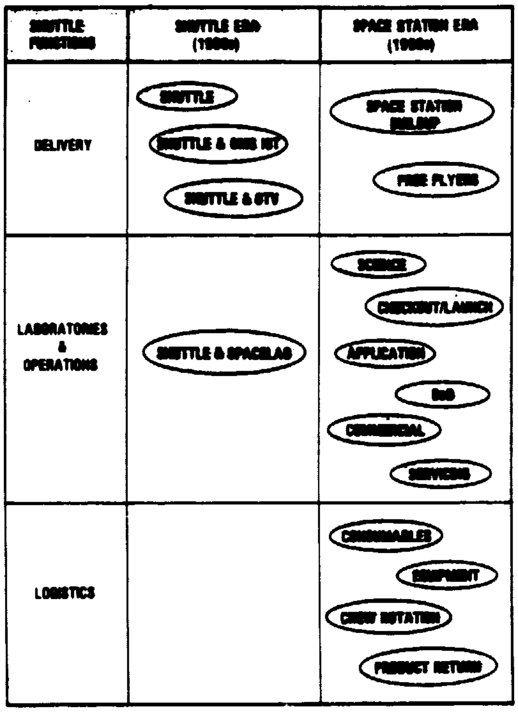


Figure 8. The diversity of cargo in the Space Station era results in more efficient Shuttle utilization.

Support Facilities — Applicable STS support elements include launch complexes and Shuttle and cargo ground processing facilities at Kennedy Space Center (KSC) and Vandenberg Air Force Base (VAFB), and the communications and data-handling network. The Tracking and Data Relay Satellite System (TDRSS) will provide near-continuous, real-time communications links between the Space Station and users on the ground. Other terrestrial and satellite links will tie in to ground control and data analysis stations internationally.

STS PAYLOAD ACCOMMODATIONS

Throughout the 1980s and 1990s, the Space Transportation System will be evolving in capabilities as previously described. This section provides quantified ranges of values of mission support and payload accommodation capabilities of STS elements, beginning with the Shuttle and extending to the Space Station.

Table 1 is a summary of the resources available to payloads. The values shown include estimated ranges for strawman Space Station configurations.

All STS elements will be supported by the Tracking and Data Relay Satellite System (TDRSS), which will enable data transfer to the earth at rates of 50 kbps continuously and up to 300 kbps when a single-access channel is available.

Table 1. STS element payload accommodation capabilities will evolve through several growth stages.

	STS Element					
System Attribute Provided to Payloads	**Space Shuttle**	**Shuttle With Spacelab**	**Space Platform**	**Initial Space Station**	**Operational Space Station**	**Advanced Space Station**
Power (kW)	7	2 to 5	10 to 20	10 to 20	20 to 40	≥40
Maximum mission duration	7 to 30 days	7 days	Unlimited	Unlimited	Unlimited	Unlimited
Crew capability	1 or 2	1 to 4	0	1 to 4	4 to 8	≥8
Volume (m^3)						
(Pressurized)	2 to 4	17	0	25	50	≥50
(Unpressurized)	304	60	500	400	1,000	≥1,000
Weight (kg)	29,000	6,000 to 9,000	15,000	8,000 to 10,000	10,000 to 20,000	≥20,000
Microgravity (g)	10^{-3}	10^{-3}	10^{-6} to 10^{-7}	10^{-4} to 10^{-6}	10^{-4} to 10^{-6}	10^{-4} to 10^{-6}
Orbital access (km)	100 to 1100	185 to 555	370 to 555	390 to 450	390 to 450	390 to 450
(deg incl)	28.5 to 104	28.5 to 104	28.5 to 104	28.5	28.5 to 104	28.5 to 104
Availability	Now	1983	TBD	1990	1995	TBD

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SPACE SHUTTLE & SPACE STATION FINANCIAL DATA

Users of the Space Shuttle and other elements of the Space Transportation System (STS) are required to pay NASA for these services in accordance with reimbursement guidelines established by NASA's Office of Space Transportation Operations. NASA's current STS pricing policy is summarized in the following paragraphs (All prices in 1982 dollars).

REGULAR FLIGHTS

For standard missions to low earth orbit (with cargo space shared among two or more users), each Shuttle user is charged according to the fraction of available Orbiter cargo bay space his payload occupies. Charges are calculated as follows:

Step 1.

Calculate *weight load factor* $= \dfrac{\text{Payload weight}}{65{,}000\ \text{lb}}$

Calculate *length load factor* $= \dfrac{\text{Payload length}}{60\ \text{ft}}$

Determine *load factor* **= greater of weight load factor, length load factor**

Step 2.

Calculate *charge factor* $=$ **load factor** $\times \dfrac{1}{0.75}$

Step 3.

Multiply *charge factor* by *dedicated price*.

The dedicated price is the charge a user would pay for use of the entire Orbiter cargo bay, and is presently set at $70.8 million. A user with a charge factor of 0.10 would be charged 0.10 × $70.8 million = $7.08 million. NASA has established a minimum load factor of 0.05 (charge factor = 0.067).

SPECIAL FLIGHTS

Shuttle users with flexible launch dates, very small payloads, or other special characteristics can take advantage of special pricing considerations, which include:

- Standby Basis — Users who can prepare payloads on short notice and who have flexible launch dates can fly on a standby basis at a 20% discount. At least 60 days advance notice is provided by NASA.
- Small Self-Contained Payloads (Getaway Specials) — Users with very small scientific research and development payloads can have their experiments flown in the cargo bay in special NASA-supplied canisters at relatively low cost. Three types of accommodations are available:

Maximum Weight (kg)	Maximum Volume (m^3)	Price
91	0.14	$18,620
45	0.07	$ 9,310
27	0.07	$ 5,586

- Mid-Deck Lockers — A limited number of small storage lockers in the Orbiter mid-deck crew compartment are available for payloads that do not require vacuum or large amounts of power. Each locker has $0.057 m^3$ volume and 27.3 kg weight capacity; large lockers (with twice the weight and volume capacity) are also available. Prices for mid-deck lockers have not yet been established.
- NASA-Subsidized Flights — Companies with research and development experiments related to materials processing in space (MPS) and aimed at eventual commercialization, can negotiate with NASA for Joint-Endeavor Agreements (JEA). Under terms of a JEA, NASA can provide the industrial JEA participant with flight time on the Space Shuttle (or other elements of the STS) and use of NASA ground facilities in exchange for nonmonetary considerations; e.g., use of samples. There is no established limit to the value of NASA support available to users through JEAs and Joint Endeavor proposals can be submitted to NASA at no cost.

HIGH-ENERGY ORBITS

Users requiring payload launches to high (e.g., geosynchronous) orbits can use upper-stage boosters launched from the Orbiter cargo bay. The approximate costs and capabilities of upper stage services are:

Upper Stage	Payload Weight Capacity (kg)	Orbit Achieved	Charge Factor	Shuttle Price ($M)	Upper-Stage Cost ($M)	Payload Services Charge ($M)	Total Price ($M)
Delta Payload Assist Module (PAM-D)	1,088	GEO-transfer	0.21	14.9	6.6	1.2	22.7
Atlas-Centaur Payload Assist Module (PAM-A)	2,000	GEO-transfer	0.35	24.8	8.8	3.9	37.5
Inertial Upper Stage (IUS)	2,270	GEO	1	70.8	55	10	135.8

SPACE STATION COSTS

As a possible future STS element, the Space Station could offer potentially significant economic benefits to users with long-duration or high-energy missions. The cost per man-day of crew labor onboard a Space Station has been estimated at about $135,000*. Other cost bases, such as dollars per kilowatt-hour for electrical service, are TBD.

* *Boeing, SOC System Analysis Study Extension, Vol. I, Exec. Summary, p. 7.*

Launch of high-energy missions for a Space Station could be highly cost-effective. Using a reusable OTV based at a Space Station, an IUS-class (2,270 kg) payload might be delivered to geosynchronous orbit for as little as $40 million, less than one-third the cost of using the Shuttle-IUS combination.

Exploration of other Space Station uses is expected to identify other economic benefits of a Space Station.

GENERAL DYNAMICS
Convair Division

SPACE STATION USER FACT SHEET

PROPRIETARY DATA

You are requested to clearly identify any information in these fact sheets that you consider to be proprietary. General Dynamics Convair Division agrees that it will use the same reasonable efforts to protect such information as are used to protect its own Proprietary Information. Disclosures of such information shall be restricted to those individuals who are directly participating in the data coordination and interchange efforts.

GENERAL INFORMATION

Organization Name and Address ______________________________

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Principal Contact ______________________________

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Phone ______________________ Date ______________________

Title of Experiment/Product/Process ______________________________

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Objective ______________________________

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Summary Description ______________________________

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Reference Documents ______________________________

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CONTENTS

GENERAL DYNAMICS
Convair Division

INTRODUCTION

The fact sheet is divided into three sections. The first, "Economic Factors," is quite general in nature and addresses investment considerations and potential benefits of a Space Station as they apply to industrial organizations. The next two sections, which discuss Planning Factors and Technical Parameters, are somewhat more detailed and are oriented toward capturing data on currently planned space activities or to providing a basis for developing such payload planning data.

Please keep in mind that we are interested in your concepts and ideas (as well as specific data, if available) and that we fully understand that you may not be able to answer many of the detailed planning or technical questions. Answer as many inquiries as you can at this time, and return the Fact Sheet to General Dynamics. The format, organization, and contents are designed to minimize the time required to answer the questions and to recognize the engineering and scheduling uncertainties inherent in long-range planning. We plan to follow up your efforts with future contacts, during which we may be able to offer assistance and work together in further developing Space Station user planning data.

To the majority of inquiries, you can respond by simply checking the applicable answer. However, where more detailed information is available, space has been provided to enter such data. For your convenience, provisions are made for you to use either English or SI units.

The data that you provide to General Dynamics will be used for Space Station program planning purposes only. This is an initial, informal step that will help shape the evolutionary design of the Space Transportation System (STS), particularly the Space Station. Later, as your support requirements and user benefits are defined in greater detail, you will have the opportunity to formalize your participation through the STS Customer Services Office at NASA Headquarters.

Potential user technical requirements data described in these Fact Sheets should be limited to only those resources or services that are required by the user-provided equipment at the interface with elements of the Space Transportation System. Requirements internal to the user equipment should not be described herein. For purposes of these data sheets, the terms "experiment", "product", or "process" have been used interchangeably to indicate the generic function provided by the user equipment.

In addition to potential users, this Fact Sheet also addresses inquiries to organizations that may be interested in Space Station-related business opportunities for providing services (such as power or data management support) to Space Station users.

Your organization may be interested in more than one use of space facilities. A separate set of Fact Sheets should be prepared for each different product, process, experiment or operation that has significantly different requirements. (An extra set of Fact Sheets is provided for your convenience.)

MAILING INSTRUCTIONS

When completed, please return this questionnaire to:

General Dynamics Convair Division
Space Station Project, MZ 21-9530
P.O. Box 80847
San Diego, CA 92138

GENERAL DYNAMICS
Convair Division

ECONOMIC FACTORS

The following questions are designed to provide a general indication of the economic/industrial value of a Space Station for commercial users.

NASA Relationship

1. Please check your company's level of direct working experience with NASA.

- ☐ substantial
- ☐ moderate
- ☐ low
- ☐ none

2. How would you assess your interest in exploring possible joint-endeavor arrangements with NASA?

- ☐ very interested
- ☐ moderately interested
- ☐ not interested
- ☐ unknown

Investment Considerations

1. Please indicate what you would consider to be the greatest acceptable investment horizon (before realizing dollar returns) in a Space Station-related business venture.

- ☐ over 20 years
- ☐ 15 to 20 years
- ☐ 10 to 15 years
- ☐ 5 to 10 years
- ☐ Less than 5 years
- ☐ unknown

2. Please indicate the greatest level of dollar commitment you could envision your company making toward Space Station utilization.

- ☐ over $100 million
- ☐ $10 to 100 million
- ☐ $1 to 10 million
- ☐ less than $1 million
- ☐ unknown

3. Please indicate how you would characterize the level of risk involved in your company's potential or planned Space Station activities.

- ☐ great risk
- ☐ significant risk
- ☐ average risk
- ☐ low risk
- ☐ not applicable/unknown

4. Please indicate how you would rate the significance of the following barriers to investment in a Space Station?

	Great	Moderate	Little	Unknown
a. investment level	☐	☐	☐	☐
b. investment horizon	☐	☐	☐	☐
c. technical risk	☐	☐	☐	☐
d. legal problems	☐	☐	☐	☐
e. uncertainty regarding govt commitments	☐	☐	☐	☐

5. Please indicate how you would rate the potential significance of the following incentives to Space Station investment?

	Great	Moderate	Little	Unknown
a. reduced space transportation costs	☐	☐	☐	☐
b. competitive pressure	☐	☐	☐	☐
c. govt-sponsored R&D	☐	☐	☐	☐
d. govt logistical support (e.g. no-monetary cost Shuttle flights)	☐	☐	☐	☐
e. govt tax or other economic incentives	☐	☐	☐	☐

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Space Station Benefits

1. How would you characterize the potential of the Space Station to reduce the costs or increase the efficiency of the relevant activities you are involved in?

- ☐ great potential
- ☐ moderate potential
- ☐ little potential
- ☐ unknown

2. In your estimation, what would be the approximate net annual dollar value to your company of access to a Space Station?

- ☐ over $100 million
- ☐ $10 to 100 million
- ☐ $1 to 10 million
- ☐ less than $1 million
- ☐ unknown

3. What is your perception of the potential industrial value of a Space Station?

- ☐ unlimited value
- ☐ high value
- ☐ marginal value
- ☐ little value
- ☐ unknown

4. Please explain any other economic factors that you feel are significant in "Notes."

NOTES:

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PLANNING FACTORS

The following questions will provide an initial overview of how your organization's uses of space resources could evolve during development of space-related products/services. For each specific space-related program you are considering or have under way, please check the appropriate column(s) based on your current understanding of the phases of your product development cycle and the STS and its attributes and opportunities. For example, if the Space Shuttle could be used for demonstration of your product/process and for pilot commercialization, check (✓) columns B and C for item 1.

OPERATIONAL CAPABILITIES

For which activity phase(s) does your organization anticipate...

	PHASES: A EXPERIMENTAL	B DEMONSTRATION	C PILOT COMMERCIALIZATION	D FULL-SCALE COMMERCIALIZATION	UNKNOWN	NONE
1. Using the Space Shuttle?						
2. Using the Space Shuttle with Spacelab?						
3. Needing an unmanned Space Platform?						
4. Needing a manned Space Station?						
5. Needing trained scientists/astronauts?						
6. Launching payloads to high (e.g. geosynchronous) orbits?						
7. Launching payloads over 2270 kg to high orbits?						
8. Retrieving and/or repairing orbital satellites?						
9. Assembling large systems in space?						
10. Using non-terrestrial materials (e.g. lunar ore)?						

TIMING

Which activity phase(s) do you...

	A	B	C	D	UNKNOWN	NONE
11. Engage in presently?						
12. Expect to be engaged in by 1985?						
13. Expect to be engaged in by 1990?						
14. Expect to be engaged in by 1995?						
15. Expect to be engaged in by 2000?						

If the availability of a Space Station might significantly change your currently planned uses of space facilities, it will be necessary to complete an additional set of Fact Sheets — one for your current program and one to show anticipated requirements if your program is modified or expanded to make use of a Space Station. Also, if it appears that different activity phases of your product development cycle will have significantly different requirements, or if you have a number of independent products, then separate fact sheets should be prepared for each development phase or for each independent product.

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16. Please provide an overview of your anticipated use of the STS (e.g. for full-scale commercialization using the Space Station, describe the total duration, length of production run, time between runs, etc.) ______

17. If your organization is primarily interested as a provider of supporting services to Space Station users (e.g. power, data management, habitability, logistics), please describe the function(s) to be provided as well as significant equipment performance capabilities. Then answer any applicable questions in the next section that address Technical Parameters.

Description of functions/services to be provided. ______

18. The STS includes upper stages that provide a range of delivery capabilities for geosynchronous orbit payloads. The Payload Assist Module - Delta Class (PAM-D), for example, is delivered by the Shuttle to low earth orbit and provides spin capability up to 100 rpm and geosynchronous transfer orbit placement for spacecraft weighing up to 1,088 kg (2,400 lb). The Payload Assist Module – Atlas Centaur class (PAM-A) provides spin capability up to 65 rpm and can place spacecraft weighing up to 2,000 kg (4,400 lb) in geosynchronous transfer orbit. The Inertial Upper Stage (IUS) can place 2,270 kg (5,000 lb) spacecraft in GEO. The Shuttle-delivered Centaur F will be able to place single or multiple spacecraft up to 9.1 m (30 ft) long and weighing up to 6,350 kg (14,000 lb) in GEO. Centaur G has capabilities for placing spacecraft up to 12.2 m (40 ft) long and weighing up to 4,808 kg (10,600 lb) in GEO. If your organization is primarily interested in communications satellites or other geosynchronous orbit payloads, please briefly describe the spacecraft weight or other characteristics, transfer orbit or geosynchronous orbit placement requirements, any space operations support needed from the Space Station or Orbiter (e.g. checkout, EVA), and also the expected launch schedule. Then answer any applicable questions in the next section that address Technical Parameters.

Description of satellite and operations support required. ______

Using the following barometer for reference, please provide a numerical (1-10) answer to Questions 19 and 20.

0	1	2	3	4	5	6	7	8	9	10
NO INFLUENCE				MODERATE INFLUENCE						HEAVY INFLUENCE

19. To what degree has the possible availability of a manned Space Station influenced your company's planning for the next 20 years? ______

20. After receiving the User Brochure, to what degree do you expect the possible availability of a manned Space Station to influence your future planning for the next 20 years? ______

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TECHNICAL PARAMETERS

MISSION CHARACTERISTICS

1. Orbit Parameters

Shuttle/Spacelab and Space Station/Platform missions will typically be flown at altitudes ranging between 250 and 470 km (135 to 254 nmi), and at inclinations ranging from 28.5 to 104 degrees. Standard inclinations are 28.5 and 57 degrees.

Please indicate below the orbit parameters (altitude and inclination) or *range* of parameters compatible with your experiment.

- ☐ Any orbit is acceptable.
- ☐ Desired orbit parameters are:
  Inclination ______________ deg
  Altitude ______________ km
  or ______________ nmi
- ☐ Unknown

Should opportunities become available for orbits at inclinations or altitudes different from your desired orbit, would your experiment objective permit use of other orbits? Please indicate below acceptable orbit parameters or range of parameters.

- ☐ Acceptable orbit parameters are:
  Inclination ______________ deg
  Altitude ______________ km
  or ______________ nmi
- ☐ Special orbits, e.g., elliptical orbit — explain in "Notes"

2. Mission Duration

On standard Spacelab flights, the Orbiter will remain aloft for 7 days. This duration can be extended to 30 days if the necessary provisions are added. The Space Station/Platform (with periodic resupply) can provide an unlimited mission duration. Please check (✓) the mission duration required to achieve the desired objectives of your experiment.

- ☐ less than 4 days
- ☐ 5 to 7 days
- ☐ 8 to 15 days
- ☐ 16 to 30 days
- ☐ 30 to 60 days
- ☐ 60 to 90 days
- ☐ 90 to 180 days
- ☐ 180 to 365 days
- ☐ 1 to 2 years
- ☐ 2 to 5 years
- ☐ greater than 5 years

Estimate mission duration, if possible: ______________
____

PHYSICAL CHARACTERISTICS

1. Weight

Keeping in mind the Shuttle capabilities for payload delivery, please check (✓) the estimated weight of user provided equipment (include consumables, if applicable).

- ☐ less than 30 kg
- ☐ 30 to 100 kg (220 lb)
- ☐ 100 to 300 kg (660 lb)
- ☐ 300 to 1000 kg (2,205 lb)
- ☐ 1,000 to 3,000 kg (6,615 lb)
- ☐ 3,000 to 5,000 kg (11,025 lb)
- ☐ 5,000 to 14,515 kg (32,000 lb)
- ☐ 14,515 to 29,485 kg (65,000 lb)
- ☐ greater than 29,485 kg — explain in "Notes"
  Estimate weight, if possible:
  ______________ kg, or ______________ lb

2. Equipment Location

The Shuttle/Spacelab and Space Station/Platform provide equipment mounting provisions in pressurized and unpressurized locations. Please indicate the type of mounting provisions you desire:

- ☐ pressurized location
- ☐ unpressurized location
- ☐ both pressurized and unpressurized
- ☐ unknown

NOTES:

3. Pressurized Volume

If you indicated a desire for a pressurized location, please estimate the volume of pressurized equipment.

Volume ____________ m^3, or ____________ ft^3

4. Equipment Size (unpressurized)

The overall clearance envelope in the Orbiter cargo bay measures 18.3 m (60 ft) in length and 4.6 m (15 ft) in diameter. If you indicated a desire for unpressurized equipment location, please check (✓) the estimated length of your experiment equipment as packaged for Shuttle launch and mounted to a special support structure located in the cargo bay. (The support structure will generally reduce the cargo bay size available to the user equipment.)

- ☐ less than 2 m (6.6 ft)
- ☐ 2 m to 5 m (16.4 ft)
- ☐ 5 m to 10 m (33 ft)
- ☐ 10 m to 15 m (49 ft)
- ☐ 15 m to 18.3 m (60 ft)

Estimate length, if possible:
____________ m, or ____________ ft

Estimate width, if possible:
____________ m, or ____________ ft

5. Scientific Airlock

The Spacelab or Space Station can carry a scientific airlock capable of extending experiments into space and retracting them. Instruments using the airlock can receive services provided by the Spacelab or Space Station.

A scientific airlock:

- ☐ is not needed by this experiment
- ☐ is needed by this experiment
- ☐ may be needed by this experiment

6. Optical Window

A high-quality optical window that provides viewing access to earth, deep space, and the sun can be made available to the user.

A high-quality optical window:

- ☐ is not needed by this experiment
- ☐ is needed by this experiment.
- ☐ may be needed by this experiment
- ☐ Special physical characteristics or installation constraints — explain in "Notes"

RESOURCES

1. Electrical Power

Depending on the configuration of Spacelab elements, the Orbiter can provide up to approximately 5 kW continuously to users. Without Spacelab, the available power increases to 7 kW. A typical Space Station/Platform could supply 10 to 40 kW or more, depending on the evolutionary phase. Please check (✓) the estimated average power requirements for operating your equipment.

- ☐ none
- ☐ less than 100 watts
- ☐ 100 to 500 watts
- ☐ 500 to 1,000 watts
- ☐ 1 to 2.5 kW
- ☐ 2.5 to 5 kW
- ☐ 5 to 10 kW
- ☐ 10 to 20 kW
- ☐ 20 to 40 kW
- ☐ greater than 40 kW — explain in "Notes"

Estimate power, if possible:
____________________________ watts.

Please estimate the daily energy required by your experiment equipment.
____________________________ kWh/day

NOTES:

2. Orientation/Targets

The Orbiter or Space Station/Platform can provide pointing at any desired inertial, local vertical, earth-fixed, or orbital object target.

Does your experiment require instrument pointing?

☐ No ☐ Yes

<u>If no, skip to Question 6.</u>

If pointing is required, please check (✓) the target(s) for your experiment.

- ☐ sun
- ☐ celestial targets
- ☐ earth's limb
- ☐ geomagnetic field lines
- ☐ orbital object targets
- ☐ nadir
- ☐ specific earth targets
- ☐ swath across earth
- ☐ other — explain in "Notes"

3. Experiment Pointing

If experiment pointing and stabilization requirements exceed STS capabilities, the instrument must be installed on an Experiment Pointing Mount (EPM). Several types of NASA-provided mounts will be available, or the experiment itself may include a pointing and stabilization capability.

Please complete the following statement.

Pointing will be provided by:

- ☐ the experiment
- ☐ a NASA-provided EPM
- ☐ unknown

4. Pointing Accuracy

Please check (✓) the pointing accuracy range required by your instrument at the interface (expressed as maximum allowable error).

- ☐ unknown
- ☐ greater than 2 degrees
- ☐ 2 to 0.5 degree
- ☐ 0.5 to 0.1 degree
- ☐ 360 to 60 arc sec
- ☐ 60 to 10 arc sec
- ☐ 10 to 1 arc sec
- ☐ less than 1 arc sec

Or, estimate pointing accuracy requirement, if possible: ________________ arc sec

5. Pointing Stability

Please check (✓) the pointing stability range required by your instrument at the interface (expressed as maximum allowable error).

- ☐ greater than 360 arc sec
- ☐ 360 to 20 arc sec
- ☐ 20 to 1 arc sec
- ☐ 1 to 0.1 arc sec
- ☐ less than 0.1 arc sec

Or, estimate stability requirement, if possible: ________________ arc sec

Please list any other important pointing accuracy and stability requirements below:

____
____
____
____
____
____
____
____

NOTES:

6. Real-Time Communication Coverage

Communications contacts between the Orbiter or Space Station/Platform and ground control stations (via the Tracking and Data Relay Satellite System) are dictated by orbit parameters and Orbiter attitude. Real-time communications will be possible for 90% to 95% of the time. For normal operation of this experiment, real-time communication with the ground:

- ☐ is needed
- ☐ may be needed
- ☐ is not needed

7. Data Management/Communications

Do you need any of the following data management/communication functions from the STS.

- ☐ digital tape recording
- ☐ analog tape recording
- ☐ display/keyboard
- ☐ general purpose computer
- ☐ TV
- ☐ voice
- ☐ timing
- ☐ guidance/navigation/control
- ☐ rendezvous
- ☐ caution and warning
- ☐ other services — explain in "Notes"
- ☐ no data management services required

8. Data Rates

If your experiment needs real-time communication, please estimate, if possible, the data rate requirements.

- ☐ downlink digital rate ____________ bps
- ☐ uplink digital rate ____________ bps

Other resource requirements ☐ — explain in "Notes"

ENVIRONMENTS

1. Acceleration Level

Depending on orbit altitude, background acceleration levels caused by atmospheric drag on the Orbiter or Space Station/Platform will vary between approximately 10^{-4} and 10^{-8}g.

Please check (✓) the maximum allowable background acceleration level for your experiment.

- ☐ 10^{-4}g ☐ 10^{-5}g
- ☐ 10^{-6}g ☐ 10^{-7}g
- ☐ 10^{-8}g
- ☐ any of the above
- ☐ other — explain in "Notes"

Attitude maneuvering, crew activity and subsystem operations will induce acceleration transients in the range of 10^{-2} to 10^{-4}g for the Orbiter and 10^{-4} to 10^{-6}g for typical Space Stations. Typical unmanned Space Platforms will induce lower acceleration transients. These transients can be avoided for finite time periods by controlling crew activity and subsystem operations (i.e., timelining to avoid conflicting operations).

Please check (✓) the maximum allowable acceleration transient level for your experiment in the on-orbit configuration, e.g., unpackaged or deployed.

- ☐ 10^{-2}g ☐ 10^{-3}g ☐ 10^{-4}g
- ☐ 10^{-5}g ☐ 10^{-6}g ☐ 10^{-7}g
- ☐ less than 10^{-7}g
- ☐ any of the above.
- ☐ Other — explain in "Notes".

If your experiment requires a specific controlled gravity level (i.e., artificial g) or range of levels, please explain in "Notes".

NOTES:

2. Ambient Pressure

As orbital altitude increases, the atmospheric pressure surrounding the Orbiter and within the cargo bay or around the Space Station/Platform will, of course, decrease.

Does your experiment require exposure to the space environment (e.g., externally mounted or in an airlock)?

☐ Yes ☐ No

If no, continue to the next question.

If exposure to the space environment is required, please check (✓) the maximum atmospheric pressure allowable. (The approximate corresponding altitude is also given.)

- ☐ 5×10^{-5} N/m^2 at 250 km (3.8×10^{-7} Torr) (135 nmi)
- ☐ 2.5×10^{-5} N/m^2 at 287 km (1.9×10^{-7} Torr) (155 nmi)
- ☐ 1×10^{-5} N/m^2 at 342 km (7.6×10^{-8} Torr) (185 nmi)
- ☐ 5×10^{-6} N/m^2 at 390 km (3.8×10^{-8} Torr) (210 nmi)
- ☐ 2.5×10^{-6} N/m^2 at 440 km (1.9×10^{-8} Torr) (238 nmi)
- ☐ 1×10^{-6} N/m^2 at 512 km (7.6×10^{-9} Torr) (276 nmi)
- ☐ any of the above
- ☐ other — explain in "Notes"

3. Contamination Sensitivity/Generation

Experiments can be influenced by environments produced by the Orbiter or Space Station/Platform or by other experiments. On the other hand, experiments can produce conditions that might influence other experiments if emitted. Please review the list below and check (✓) those factors that would adversely affect your instrument or experiment or which might be produced and emitted by your experiment.

a. Particulate Contamination:
Sensitive
no ☐ maybe ☐ yes ☐
Emit
no ☐ maybe ☐ yes ☐

b. Gaseous Contamination:
Sensitive
no ☐ maybe ☐ yes ☐
Emit
no ☐ maybe ☐ yes ☐

c. Radioactivity:
Sensitive
no ☐ maybe ☐ yes ☐
Emit
no ☐ maybe ☐ yes ☐

d. Electromagnetic Fields (RF):
Sensitive
no ☐ maybe ☐ yes ☐
Emit
no ☐ maybe ☐ yes ☐

e. Magnetic Fields:
Sensitive
no ☐ maybe ☐ yes ☐
Emit
no ☐ maybe ☐ yes ☐

Other environmental requirements ☐ — explain in "Notes"

NOTES:

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CREW/EXPERIMENT CONTROL

1. Crew Time

The Orbiter can provide one to four Payload Specialists to conduct experiments. Each Payload Specialist can devote about 8 to 10 hours per day to conducting experiments. The Space Station can provide a manned presence for essentially unlimited periods of 1 to 8 or more crewmen, depending on the evolutionary phase. Remembering that crew time may be needed for tasks such as activation, monitoring, controlling, equipment stowage, and results analysis, please check (✓) the estimated average crew hours per day required by your experiment.

- ☐ none
- ☐ less than 0.5 hr/day
- ☐ 1 to 2 hr/day
- ☐ 2 to 4 hr/day
- ☐ 4 to 8 hr/day
- ☐ 8 to 16 hr/day
- ☐ 16 to 32 hr/day
- ☐ 32 to 64 hr/day
- ☐ 64 hr/day

or, estimate crew time if possible. ______ hr/day

- ☐ Special crew requirements — explain in "Notes"

2. Crew Training

STS crewmembers can be provided by NASA and given specialized training for operation of the experiment equipment, or suitably trained representatives can be provided by the user. Please check (✓) the appropriate crew training method(s) and indicate number of crew members required.

- ☐ crewmember(s) not required.
- ☐ NASA-provided crewmember(s), ______ No. required
- ☐ user-provided crewmember(s), ______ No. required
- ☐ unknown

NOTES:

3. Experiment Control

Experiment operations can be controlled on-board, or by digital commands issued from the ground. Please check (✓) the applicable method(s).

- ☐ by on-board crew
- ☐ by on-board computer
- ☐ by digital command from ground
- ☐ no control required

Experiment operations can vary from simple to highly complex. Please check (✓) as applicable.

- ☐ experiment requires only "on/off" commands.
- ☐ experiment requires preprogrammed control.
- ☐ experiment requires manned, real-time active control
- ☐ other unique control requirements — explain in "Notes".

4. Extravehicular Activities (EVA)

The Orbiter or Space Station provides the systems and personnel needed to perform manual tasks outside the pressurized work area.

EVA can be used for operation of equipment, deployment, positioning, and retraction of booms, cargo transfer, etc.

Please check (✓) one.

- ☐ EVA is not needed for the normal operation of this experiment.
- ☐ EVA is needed for the normal operation of this experiment.
- ☐ EVA may be needed for normal operation of this equipment.

Other crew-related requirements ☐ — explain in "Notes".

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SPACE OPERATIONS/LOGISTICS

1. Space Operations

The STS could offer a wide variety of space operations functions for users, or the functions could be provided by your equipment. Do you anticipate use of, or would you provide any of the following typical functions?

Construction	use ☐	provide ☐
Assembly	use ☐	provide ☐
Alignment	use ☐	provide ☐
Service	use ☐	provide ☐
Maintenance	use ☐	provide ☐
Checkout	use ☐	provide ☐
Deploy	use ☐	provide ☐
Retrieve	use ☐	provide ☐
Dock	use ☐	provide ☐
Propellant handling	use ☐	provide ☐
Propellant storage	use ☐	provide ☐

Space operation functions may be needed ☐, provided ☐
Space operation functions are not needed ☐, not provided ☐
☐ other space operations — explain in "Notes"

If you indicated use of, or provision of, any space operations functions, briefly describe the characteristics or limitations in "Notes" (e.g., type/size or frequency of instrument servicing or maintenance, the propellant type (H_2, O_2, N_2H_4, etc.) or propellant quantity handled or stored, the type/size or frequency of items to be deployed or retrieved.)

NOTES:

2. Logistics

Do you anticipate the need to resupply materials or expendables or return samples/products?

Resupply
no ☐ maybe ☐ yes ☐
Return to Earth
no ☐ maybe ☐ yes ☐

If logistic support is anticipated, please describe the nature of support in terms of item type, weight, volume, and frequency in "Notes".

EXPERIMENT SUPPORT

1. Storage

Do you require storage provisions for raw materials or finished products, film, etc.?

no ☐ maybe ☐ yes ☐

If storage is needed, please describe storage requirements.

___
___
___

Do you require special protection/control from the STS? (e.g., refrigeration, light protection)

no ☐ maybe ☐ yes ☐

If protection is needed, please describe protection requirements.

___
___
___
___

Does your experiment involve live specimens?

no ☐ maybe ☐ yes ☐

If live specimens are involved, please describe support requirements.

___
___
___
___

Other experiment support ☐ — explain in "Notes"

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SAFETY

1. Potential Hazards

Do you anticipate any of the following potential hazards to be associated with your experiment, product, or process?

- ☐ high pressure
- ☐ pyrotechnics
- ☐ radiation
- ☐ cryogenics
- ☐ propellants
- ☐ corrosive
- ☐ toxic substances
- ☐ other — explain in "Notes"

OTHER ACCOMMODATION CONSIDERATIONS

1. Experiment Compatibility/Flexibility

Is your experiment of such a nature that it would be desirable to be conducted in isolation from manned presence?

no ☐ maybe ☐ yes ☐

Would isolation from other equipment be desirable? (e.g., use of a free flyer)

no ☐ maybe ☐ yes ☐

Please describe special isolation requirements.

____
____
____
____

Would sharing a general-purpose facility be an acceptable accommodation for your experiment? (e.g., consider proprietary process, security, etc).

no ☐ maybe ☐ yes ☐

Special accommodation considerations ☐ — explain in "Notes"

NOTES:

MAILING INSTRUCTIONS

When completed, please return this questionnaire to:

General Dynamics Convair Division
Space Station Project, MZ 21-9530
P.O. Box 80847
San Diego, CA 92138